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PUBLIC WORKS
AND
RURAL LAND USE

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SEPTEMBER 1942

NATIONAL RESOURCES PLANNING BOARD

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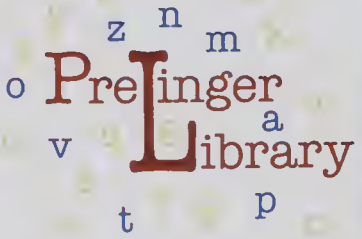

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PUBLIC WORKS
AND
RURAL LAND USE

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SEPTEMBER 1942

REPORT OF THE

LAND COMMITTEE

TO THE

NATIONAL RESOURCES PLANNING BOARD

UNITED STATES GOVERNMENT PRINTING OFFICE - - - - - - - - - - WASHINGTON : 1942

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EXECUTIVE OFFICE OF THE PRESIDENT
NATIONAL RESOURCES PLANNING BOARD
WASHINGTON, D. C.

October 29, 1942.

The PRESIDENT
The White House

MY DEAR MR. PRESIDENT:

We have the honor to transmit herewith a report on "Public Works and Rural Land Use," prepared by our Land Committee with the assistance of many Federal agencies. This report presents a revised statement of the objectives and criteria for public undertakings to conserve and improve our rural land resources. It supplements and brings up to date the materials on this subject in the Report of the National Resources Board for 1934.

Although the statement is not primarily concerned with public land acquisition, it does contain a discussion of public land acquisition as one of the effective tools for facilitating land-use adjustment. It is noted, for example, that of the 1,900,000,000 acres of land in Continental United States 415,000,000 acres are classified as crop land, of this crop land total 339,000,000 acres or 82 percent is suitable for cultivation under appropriate soil conservation practices, and the remaining 76,000,000 acres are classified as land which could not be cultivated safely and profitably under normal prices. Our policy with respect to rural public works must therefore take into account the following:

1. Promotion of those public works and undertakings required to conserve and improve crop lands suitable for cultivation, forest lands, and range lands.
2. Public acquisition of submarginal crop lands and their conversion to more suitable land uses.

The importance of this statement at this time lies in the clear indication which it provides of the needs and possibilities for activity after the war to develop these basic resources. We hope the report may stimulate the preparation now of plans for rural works of tested merit which can be undertaken when the war is won.

Sincerely yours,

FREDERIC A. DELANO, *Chairman*
CHARLES E. MERRIAM
GEORGE F. YANTIS

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FOREWORD

The National Resources Planning Board and its predecessors have given special attention to the problems of development of our land resources. In the report of the National Resources Board of 1934, a review of the major land requirements and land resources led to recommendations for new policies and programs of adjustment in rural land use and improvement. The supplementary reports of the Land Committee at that time provided a summary of the situation in each major field of land use with proposed policies for functional adjustment and development.

Following the merging of the functions of the Federal Employment Stabilization Office and the National Resources Committee when the National Resources Planning Board was established in the Executive Office of the President on July 1, 1939, it became the duty of the Land Committee to assist the Board in development of the 6-year program of public works by reviewing public works projects proposals for conservation and development of rural lands.

The first step in developing a review procedure was the preparation of a general statement of policy for rural land protection and development. That statement, entitled "Land Development Policies," appeared in the January 1941 report of the National Resources Planning Board, "Development of Resources and Stabilization of Employment in the United States." The policy statement outlined the place of a public works program on the land in the general economic program of the Nation, set forth a skeleton outline of public works for rural lands, and laid down general principles for evaluating individual public works projects on the land.

This report, "Public Works and Rural Land Use," is the result of the second step in development of a review procedure, the preparation of general plans for public works on various types of land and of evaluation principles for specific types of works projects. The report consists of statements on public works in relation to the use of land for agriculture, grazing, forestry, wildlife, and recreation. The statements were prepared by committees of technicians in the Department of Agriculture, and the Department of the Interior, under the direction of the Evaluation Subcommittee of the Land Committee, with the assistance of John B. Bennett, Secretary of the Land Committee. The members of the Evaluation Subcommittee were Charles A. Lory, President Emeritus, Colorado State College of Agriculture, Chairman; Lee Muck, Assistant to Secretary in Charge of Land Utilization, Department of the Interior; and Julius T. Wendzel, in charge of Interdepartmental Coordination, Office of Land Use Coordination, Department of Agriculture.

Although forming a part of a joint effort, each statement is fairly complete in itself. Each outlines the general objectives of the program of land conservation, development, and economic use of land resources in the particular field covered, indicates the types of public works which contribute toward the accomplishment of this program, and sets forth certain criteria for evaluating individual works projects of various types. In some instances the apparent quantitative needs for public works of certain types are indicated.

The statements contain information which should be valuable to agencies engaged in planning and construction of public works on rural lands, in their preparation of preliminary plans for public works projects. They also should be useful to local, State, and regional planning agencies which, although not themselves engaged in construction, are interested in seeing that specific public works projects in their areas are in accord with broad programs of development. Finally, they should provide a background for the review of public works proposals by the Board, the Bureau of the Budget and appropriation committees of the Congress.

Preparation of the statements was begun more than a year ago, before defense production had reached a level high enough to curtail civilian public works appreciably. The current war effort requires the practical suspension of many of the works programs outlined in these statements, but it is now all the more desirable that the planning of these programs should go forward, so that public works on rural lands may make their proper contribution to improvement of our resources, increases in the standards of rural living, and maintenance of full employment during the postwar period.

PART I—PUBLIC WORKS AND AGRICULTURAL LAND[1]

1. OBJECTIVES, SITUATION, AND SETTING

The Nation's land—soil, water, and other resources—exists for its people. Public works and activities affecting the soil and water resources essential to agriculture must have as their first objective meeting the needs of people for food, fiber, and other products of the farm, and meeting these needs adequately, and with stability. Agriculture must make such provision for all persons, rich or poor, rural or urban. Agriculture must provide what people want as well as the amount they want; hence both the rate and nature of agricultural production must be tuned to consumption needs and demands, and agricultural land use must, in turn, be adapted to production requirements.[2]

Consumption Requirements Increasing

A study of the situation and outlook with respect to the need for farm products as compared to the supply and productive capacity of the land upon which such products must be produced leaves no doubt that a goal of high-level consumption for all requires major emphasis on the rehabilitation, conservation, and development of land for agricultural use. At this particular time, the United States is engaged in a tremendous world war in which food and more food are of extreme importance both in conducting the war and in post-war reconstruction. There is now under way a vast "Food for Freedom" program in which every effort is being exerted to increase the production of needed foods for America and her allies. Consideration of longer-range factors suggests that American agriculture must also plan to meet a continuous demand for farm products well above that for recent years.

In estimating the needs for agricultural land during the next 20 years or so, two factors must be kept in mind: (1) the probable demand for farm products, and (2) the peculiar nature of agriculture as a mechanism to supply farm products.

Stating the need for farm land purely in terms of the number of people to be fed, clothed, and sheltered, it must be concluded that the agricultural plant will have to be expanded. Although population is increasing at a much smaller rate than in the nineteenth century and a stationary or even declining population is in sight if present trends in the net reproduction rate continue and if no change in immigration occurs, estimates made under peacetime conditions indicate that we may anticipate an increase in population of 15,000,000 to 20,000,000 by 1960, depending upon the premise selected.[3]

In addition to increased numbers to be fed, clothed, and sheltered, the accomplishment of the goal for more adequate nutrition will add to the demand for food. To a considerable extent good diets can be realized by consuming the right kinds of food rather than more food but some increase in per capita volume of food consumed will be necessary if we are to have adequate diets. It should be kept in mind, however, that for the past 40 years the trend in consumption habits of the American people has been away from cereals, beef, and other "land using" foods to fruits, vegetables, dairy, and poultry products which are to a greater extent "labor consuming crops." In other words, it may be possible to secure "adequate nutrition" without adding more food-crop and pasture acres per capita to our present agricultural plant. The possibilities of achieving adequate nutrition will depend heavily on getting sufficient purchasing power into the hands of the lower income groups. There is reasonable expectation that this will be achieved.

The demand for farm products for the next two decades must be considered in two stages: (1) the de-

[1] This statement was prepared under the direction of Julius T. Wendzel, formerly of the Office of Land Use Coordination, Department of Agriculture. Contributions were made by W. R. Nelson and G. W. Lineweaver, of the Bureau of Reclamation; E. G. Arnold and P. L. Slagsvold, Farm Security Administration; M. H. Cobee, T. D. Johnson, and L. A. Jones of the Soil Conservation Service; Robert Beale, of the Rural Electrification Administration; J. J. Haggerty, of the Bureau of Agricultural Economics; and Robert Fraze, of the Office of Land Use Coordination. Materials for the section on Rural Housing were developed by an interbureau committee on rural housing and post-war planning in the Department of Agriculture.

[2] For these purposes agricultural land may be said to comprise all of the cropland and all of the open (nonwoodland) pasture, which in general is intensive in use and will carry more than one animal unit for each 10 acres. In the eastern, southern, and midwestern areas of the United States east of the Great Plains, it comprises the cropland and all of the open pastures on farms. In the arid and semiarid areas of the Great Plains, Mountain, and Western States, it comprises all of the land used either for crops or intensive pastures on the farms and ranches. It comprises no land which could be classed as woodland, whether used for pasture or range. This narrow definition and treatment of agricultural land is justified by the fact that other papers in the series, of which this is a part, treat of range land and forest land. For proper perspective this statement should be read in connection with the others in the series and also with reference to the general statement on "Land Development Policies" in Part III of the National Resources Planning Board Report of January 1941.

[3] With the impact of the war still in its early stages it is hazardous to predict, but based upon the trends set in motion during the last World War the above estimates may be too high. Death rates of men in their most reproductive years may reach abnormal heights while birth rates decrease just as abruptly during the duration of a war. The recovery of birth rates after the war cannot restore the generations lost during the duration of the struggle.

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mands during the war, (2) the demands after the war. While the war lasts extreme efforts will have to be made to increase agricultural production to provide food for America and her allies. In certain lines, this will mean an over-expanded plant, similar to those in other "war industries," which will have to be reduced drastically after the war is over.

The problem of estimating exports after the war is a most baffling one. In 1920, 64 million acres were needed to fill the requirements for our agricultural exports; this figure had shrunk to 18 millions in 1934–35. The 1942 production goals for agriculture contemplate exports involving 26 million acres which about equals the 1936–40 acreage. While the war demands will sustain the need for this acreage there is no way of predicting the post-war demands. Devastated and hungry foreign nations will no doubt be in dire need for food, seeds, and work stock, but will also be deficient in buying power. A successful peace embodying a "rational trade policy" might give permanence to a somewhat higher volume of exports. On the other hand, should a "rational trade policy" involve a lowering of our tariff walls against Canadian, and Latin American farm products, it could easily neutralize the favorable features of such a policy. Admitting Cuban and Puerto Rican sugar, for instance, on a more liberal basis would directly affect American cane and beet sugar producers.

Another uncertain but "bullish" factor in the demand for farm products is the probable increase in industrial uses for raw materials from the farm. Tending to offset this is the continued mechanization of agriculture. During 1915–39 motor equipment displaced 10 million horses and mules and thereby released the products of 30 million acres of cropland and 15 million acres of pasture to produce food for human consumption. In general, the long range outlook is for a level of demand for agricultural products above that for recent years.

The Source of Future Farm Products

Given a certain demand for more food and fibers, how can this demand be met? In answering this question the unique characteristics of agriculture as an industry become apparent. In some ways it can be compared with manufacturing but in other ways it has distinct features of its own. The increased future demand for shoes can be met by running the present factories in two or three shifts instead of one 8-hour shift or by adding new factories, or both. Perhaps production could be speeded up by substituting new and more efficient machines for outmoded equipment and placing factories under better management. The same holds for agriculture. The additional farm products needed for the subsistence of the anticipated 15,000,000 to 20,000,000 people can come from the land already in farms by intensifying the use of the land, by better equipment and more efficient management, or it can come by adding new farms through reclamation and settlement.

The limitations to expanding agricultural production on existing acres will be the increased cost of intensification and the ability of farmers to "step up" management. It is important to remember that the efforts of the agricultural experiment stations and colleges have always been directed toward more efficient production. Agriculture is constantly improving its techniques and more people can be sustained on the present acreage than at any time in our history. Pasture improvement, new varieties of crops, such as hybrid corn, better feeding methods, fertilization, and other practices have increased the yield per acre and per farmer.

It is possible to add to agricultural production without increasing the total acreage in farms by better farm management. Those engaged in farm management research and extension feel that most of their work has been with a small upper group who have readily adopted successful farm management practices. Agricultural production can be increased and the income of farmers increased as fast as the other two-thirds can be "reached" and taught the principles of good farm management. This cannot be a rapid process but should not be omitted from consideration.

Another source of additional food products is the better use of the land within the present farms and the shifting of land from lower to higher land uses. It is not always realized that the process of farm making is still going on. The 1925 census reported that over 4 million acres of land has been cleared and made suitable for crops between 1920 and 1925, almost a million acres per year, at a time when agriculture was not prosperous and the only period in our history when the total acreage of land in farms had decreased (by 32 million acres in fact). According to the 1920 census there were almost 40,000,000 acres of land "within the line fence" needing drainage, most of which could be reclaimed by the farmer without drainage-district organization. Furthermore, shifts from pasture to plowland are constantly being made.

If the production on existing farms is to be increased substantially, however, the ever-present depletion of the soil by cropping, leaching, and erosion must be checked. This offers a real challenge to our farmers and the Nation and is one of the most fruitful places for the use of public works.

The second method of increasing agricultural production is by adding more land to farms; to a degree land is now being brought into use naturally without public assistance. The birth rate on farms always has been greater than that needed to maintain the existing farm population and, while there usually is a heavy

migration of farm population to the towns and cities, during recent years there has been a large excess "dammed up" on farms. Added to these are the city persons who move in a constant stream to the farms, especially during years of industrial depression. All of these people are seeking additional land from which they may secure a living, as are those former tenants and sharecroppers who have been displaced through Government crop-control programs and increasing mechanization.

Although this constant tendency to bring more land into agricultural use will automatically help to supply the needed food for an increased population, without public guidance or assistance this effort may produce conditions which many of the past land programs have tried to correct. With limited resources, many of the new farmers settle on inferior land and become relief cases, or overtax the local schools and other public facilities of financially weak areas. Public guidance is needed to avoid settlement on land too poor to support its cultivators; public works are needed to provide adequate settlement opportunities for a considerable number of rural families which can make their most effective contribution to the Nation's production by remaining on farms.

In this connection, however, it is important to recognize that an increased demand for agricultural products does not require that more people engage in farming. While such an increased demand, as has been pointed out, will require either more agricultural land or an increase in the productivity of the present acreage, or both, it must not be interpreted as the foundation for a wholesale back-to-the-farm movement in post-war years. After the war, large numbers of men will be released from war industries and the armed forces. Agriculture must expect to absorb some of these. It should be kept in mind, however, that the number of persons living on farms prior to the war was considerably in excess of the number who could find full employment or obtain more than a subsistence income there. A sound policy for the post-war years should permit an absorption by the economic system as a whole of additional workers resulting from an increase in population, as well as of those released from war duty. To accomplish this, nonagricultural activities will have to provide a large share of the employment opportunities.

Planning for Maintenance of Agricultural Resources

Careful planning and determined action, both public and private, are necessary to restore, maintain, and increase productivity of our agricultural land resources. Many lines of action are involved in accomplishing these purposes, and a major problem is that of determining the part that each of several measures and types of activity should play in an effective, well-rounded program.

To a large extent the Nation must depend upon private individuals for the action needed to maintain and develop the resource base necessary to the permanently high level of production which, in turn, is necessary to a permanently high level of consumption. This being true, the maintenance of an adequate and stable income for farmers and workers in agriculture is a means of achieving the major objective of providing food and fiber for the population as a whole as well as being an important objective in itself. The general program designed to achieve the major goal must provide for a return to farmers sufficient to enable them to have adequate income for living after providing for the maintenance of their soil resources. It must provide sufficiently profitable opportunities in farming to attract capital, labor, and capable management for the development of the agricultural plant.

A large and stable volume of employment in nonagricultural activities is important to agricultural stability as well as to the stability of the Nation as a whole, and it too is dependent largely on the efforts of private enterprise. The development of high and stable levels of production and employment in the Nation generally should, therefore, form an important part of a general program for achieving stability in agriculture.

Provision of Rural Facilities

The provision of rural facilities, such as electrification, housing, transportation, marketing facilities, education, and medical care, is an important phase of public works in relation to agricultural land use. Such facilities affect the welfare of the people upon whom the Nation must depend for farm products and the care of its agricultural land resources, and they influence considerably the effectiveness with which agricultural lands are utilized.

General Measures

Public effort can serve to supplement the efforts of private individuals in agriculture through various general measures, such as research, education, regulation, and credit, as well as by more direct assistance and public works. Since these general measures are not covered in detail in the body of this statement, they may be mentioned briefly at this point.

Research and education may contribute a great deal to the Nation's capacity to restore, maintain, and improve the productivity of its agricultural plant. The development of scientific knowledge and its application to the growing of crops, feeding of livestock, and

managing of land may go a long way toward larger output without bringing into use additional land and with no greater input of labor or capital. The adoption of soil and moisture conserving practices and of cropping systems that conserve fertility tend to increase yields. It is important not only that new knowledge be obtained and the new information disseminated but also that people be apprised of the social benefits of land conservation and development and encouraged to plan sympathetically and intelligently with these needs in mind. The efforts of the Agricultural Extension Service, the State and local land use planning committees, the Farm Security Administration, and the Soil Conservation Service in transmitting essential information and giving guidance to farm operators are highly important in translating the results of research into practice.

Knowledge concerning the nature of our soils and their adaptability to various types of use is basic to an intelligent plan of action for wise use, conservation, and development of land for agriculture. A classification of all land in or potentially available for agriculture, if made a part of the thinking of all who guide the activities on agricultural land (private operators as well as public personnel) could be a major step toward conserving and improving the productivity of the Nation's agricultural resource base.

Adequate legislation and regulation of private activities on or relating to agricultural land can do much toward the stabilization and intelligent use of land for agricultural purposes. Rural zoning has a place in preventing the use for agriculture of land so poor that it can be used for that purpose only by exploiting the land or exploiting the people who work on the land. The cooperative regulation of use by soil conservation districts offers a significant possibility for improving the manner in which the resources available for agriculture are used.

Legislation and regulations to limit speculation are especially important in connection with new land development and settlement.

An outstanding need is provision, through State legislation or otherwise, for improvement of tenure. Without long-term, written leases or provision for reimbursing a tenant for long-time improvements, the odds are heavily against the checking of soil losses and depletion on much of our agricultural land. Education as well as regulation is important in this connection.

Stable farm ownership is a prime requisite to the effective and conservational use of agricultural land. The provision of mortgage credit on terms which enable capable farm workers to purchase family-sized farms and enable those who purchase such farms to ride out the bad years can contribute greatly toward establishing an agricultural system conducive to the conservational use of land. The provision of adequate shorter-term credit to avoid the necessity of foregoing conservational practices from time to time is also important to conservational farming. Excessive credit, based on excessive appraisal of farm values and repayment possibilities, as well as excessive interest rates, must be guarded against; for these result in burdens which decrease rather than increase the probabilities of conservational farming.

Employment Stabilization and Resource Development

The Nation as a whole is interested in stability of employment and economic opportunity as well as in the conservation and development of the resource base necessary to the provision of farm commodities to an increasing population. All people who are able to work should have an opportunity to work with a prospect of receiving a return sufficient to permit satisfactory living. Full employment of "new" workers as well as of the workers in the present population is involved.

At times when employment opportunities for the Nation as a whole become especially low, the employment aspects of public works related to agricultural land become especially important. Short-run fluctuations in employment, whether seasonal, cyclical, or the result of special disturbances such as war, present a special problem in employment stabilization. With respect to short periods of low employment, the interest tends to be focused on the employment involved in the doing of conservation and developmental work; whereas, from the longer-run viewpoint, the interest is primarily in the added productivity and permanent employment opportunities that result from its doing. The timing rather than the general nature of public works affecting agricultural land use will tend to be guided by these short-run employment stabilization factors. Their general nature and extent must be determined by their contribution to productive capacity as a permanent source of products and a permanent base for employment.

In approaching the problems of employment stabilization and resource development in relation to agricultural land, it should be borne in mind that all agricultural land-use activities must be related area by area and for the Nation as a whole to other types of land use, such as forestry, grazing, recreation, and wildlife development, and to the associated urban and industrial activities. An integrated regional approach, bolstered by the scientific classification of all lands,

both urban and rural, appears to be an ultimate necessity if true perspective is to be had with respect to public works affecting agricultural land and farm people.

In the following pages activities directly in the field of agricultural land use, with respect to which public works and assistance may play a role, will be treated under two main groups: (1) Soil conservation, erosion prevention, and run-off retardation, and (2) land development and settlement. While it is recognized that rural facilities generally are closely related to the conservation and development of resources, only two fields will be discussed in this paper; namely rural electrification and rural housing.[4] The attempt will be to present briefly the setting, nature, and program possibilities in these several fields, and to indicate such evaluation principles and considerations as have developed to date. The principles here set forth embody much thought by both specialists familiar with, and generalists interested in, these fields, but they must be considered as first attempts, to be modified by further thought and actual evaluation experience.

[4] The selection of these two for treatment in no way implies that the Land Committee considers them more important than other facilities. Educational facilities in rural areas, for example, are believed to be of basic importance in relation both to rural living and adequate care of resources.

2. SOIL CONSERVATION, EROSION PREVENTION, AND RUN-OFF RETARDATION

To meet the objective of providing a high level of farm products for the Nation as a whole, we must be concerned primarily with the conservational use of land rather than with conservation in the sense of withholding land from use and production. If our land resources are to provide for a larger population at an adequate level, the deterioration of soil resources must be checked and their productivity restored without withholding from use any large proportion of the acreage now in agricultural use.

Background and Setting

In only 200 years of agriculture, about 282,000,000 acres of land have been ruined or severely impoverished by erosion in the United States and 775,000,000 acres more have been damaged to some extent. Thus in less than 7 generations, over half of the land area of the country has been affected by soil washing and blowing. Some of the most serious injury has occurred in the last 50 years.

The damage to cropland has been particularly severe. Erosion has ruined 50 million acres of formerly cultivated land and has seriously reduced the productivity of another 50,000,000 acres.

It was only recently realized that erosion had decreased the productivity of and ruined tremendous quantities of land in the United States. Land was easy to get during the period when the States were being settled. Vast unoccupied areas lay to the west, and there were few, if any, restrictions on acquisition and transfer. Any man who wanted a farm and was willing to work could acquire one. Under such conditions it was natural that little investment of effort or money was made in safeguarding a resource as abundant as land.

The soil of the virgin continent responded readily to cultivation. It was axiomatic that land was worthless except for the crops and livestock it could produce; so forests were cleared for planting and prairies were plowed for crops. But the pioneers failed to give enough consideration to nature in planning their agriculture.

Land was plowed on critical slopes where it would inevitably wash away and be ruined. Areas were cultivated where there was insufficient rainfall to maintain crop production year after year and where the dry, unprotected soil was bound to blow when the first drought came. Crops were planted on soils that were not suited to crop production, and every rain would cut rills and gullies in the fields.

Quite possibly the problem of soil conservation would not have received such attention in the United States as it has in recent years except for the accumulating pressure of other closely related problems which brought the subject home to millions who had never thought of it before.

The dust storms which blew from the plowed-up grasslands of the Great Plains over the Capitol dome at least achieved the result of arousing political attention. During the late twenties and early thirties, floods on many American rivers became acute, causing great suffering to city populations; it was realized, as never before, that the slashing of forests upstream was partly responsible. The swollen muddy waters were vivid evidence that great damage had also been done to our soil.

Especially important was the economic factor. The agricultural depression, culminating in the early 1930's, was of deep-seated and complex origin, but its manifestations were clear and vivid—low farm prices, low farm income, huge surpluses of unwanted crops, great population pressure on the land as economic opportunities were closed in the cities. The movement of population, for almost the first time in a century, was reversed as city unemployed drifted back to worn-out acres, adding to the backed-up rural population which had nowhere to go. Dire circumstances forced a new evaluation of the relation of the farmer to the land. There was little new land to clear except at high cost.

The erosion problem could hardly be exaggerated. It was demonstrated that erosion often means the difference between marginal farming, which allows the farmer at least to break even on his operations, and submarginal farming, which affords the farmer less than a subsistence return. It was shown that erosion was not limited to scattered localities, marked by deep gullies and other land scars, but that the process was going on to some degree on almost all the agricultural land of the country, often so slowly and so uniformly that the whole surface of a field was gone before soil washing was noticed. Indeed, it was this universal and insidious characteristic that made erosion such a dangerous enemy, because remedial and preventive measures were seldom adopted until the land had been permanently damaged.

When the searchlight of public interest was focused on soil erosion, it was revealed as a primary or con-

tributing cause of numerous physical, social, and economic ills. Fields, farms, and even whole communities had been abandoned as erosion reduced productivity of the land below the marginal point. Loss of tax revenue, loss of security for debts, and the undermining of health, education, and morale followed in the wake of severe soil washing and blowing. Other products of erosion were silted reservoirs, navigation channels, irrigation and drainage works, and harbors. Water rushing unchecked from eroding fields contributed to the frequency and intensity of floods along many streams. Mud and silt in the streams affected fish and other aquatic life adversely and damaged public water systems. Wherever erosion was severe and widespread, it combined with other evils to produce social and economic maladjustments, often of grave consequence.

The first public efforts toward soil conservation were in the fields of research and education, and the chief emphasis was laid on rotations and the application of fertilizer rather than upon the avoidance of erosion.

In some cases, undoubtedly, the application of fertilizer made possible the continued cropping of lands after sheet erosion had removed much of the valuable topsoil.

But gradually far-sighted scientists and conservationists began to point out the association of soil erosion with other problems of land use and with economic maladjustments. Terraces and contour furrows to control erosion were used in some areas many years ago. Research stations were established in the Department of Agriculture in 1929 to study the causes and cures of erosion and related matters, and in 1933 the Soil Erosion Service, operating with emergency funds, was set up in the Department of the Interior.

In 1934, the National Resources Planning Board sponsored a reconnaissance survey, by the Soil Erosion Service, of the extent of soil erosion in the entire Nation. A trained force was sent into every county, completing the survey in 2 months. The results were startling even to those who had studied the problem for many years. The immensity of the damage exceeded all previous estimates. This survey was followed by the establishment of a permanent Federal Soil Conservation Service, with authority to make surveys, conduct research and investigations on soil erosion and its control, establish demonstrations of erosion control, cooperate with governmental agencies, private groups, and individuals in conserving soil and water resources, and inform and educate the public about soil conservation.

Meanwhile, however, the economic problems had already brought about national action of another kind. The Agricultural Adjustment Act of 1933, whose primary purpose was to relieve immediately the pressure of farm surpluses upon farm income, provided for reduction in acreage of certain surplus crops, in return for Government payments to the cooperating farmer. Many of these were the intertilled or row crops, like cotton, corn, and tobacco, which in general are the most soil-depleting. Soil-depleting crops annually were taken out of cultivation to the extent of some 30,000,000 acres, while acreages in soil-conserving crops, like grasses and legumes, were greatly increased. Other lands, while not planted to soil-improving or soil-conserving crops, were given a much-needed rest.

Early in 1936 the Agricultural Adjustment Act was declared unconstitutional by the Supreme Court of the United States. A new measure, called the Soil Conservation and Domestic Allotment Act, provided among other things for reduction in the acreage of surplus farm commodities—most of which were of a soil-depleting nature—and for increasing the use of cover crops, contour cultivation, improved rotations, and other soil-conservation practices. Provision was made for payments to farmers for performing conservation work of value to agriculture and to the Nation. The conservation provisions accompanying production adjustment were further strengthened by the act of 1938, which laid still greater emphasis on soil-building practices. Thus soil conservation became an integral and vital part of agricultural adjustment.

On many farms in America erosion had gone too far to be checked by the farmer without technical aid. On many other farms, the soil could be conserved only by plans laid out and followed intensively for years ahead. The possibilities of intensive operations were first developed in demonstrational areas, representative of larger farming regions with similar characteristics. Beginning around 1937 the Department of Agriculture through the leadership of the Soil Conservation Service began to concentrate its activities more and more in farmer-organized and farmer-operated soil-conservation districts. These districts are legal subdivisions of States set up under the terms of special State laws and governed entirely by the farmers living within their boundaries. The districts, as local entities, have the authority to enter into agreements with the Department of Agriculture and with any other agency of government—Federal, State, or local—for assistance in carrying out conservation operations on farm land.

Practically all these districts are being assisted by the Department of Agriculture and many of them by State and local governments. Assistance by the Department of Agriculture usually consists of technical and other assistance in the preparation and application of farm-conservation plans. As far as possible, each farm is treated as a unit and a long-range plan is made which recognizes both economic and physical factors. Before making the land-use plan, based upon

soil-conservation surveys recognizing soil type, slope, degree of erosion, and separate treatment, the land is classified as to its proper uses from the standpoint of soil maintenance and erosion control.

In 1936 Congress recognized that a complete program of flood control required watershed treatment as well as dikes, levees, and major structures. The Omnibus Flood Control Act of that year provided that in the future the Department of Agriculture should have charge of watershed treatment for conservation of water, and for retarding run-off to help protect downstream lands from flooding and siltation. Where rapid run-off tends to do serious damage to lands below, even more intensive and often additional types of land treatment and structures are necessary on upstream lands and areas.

The soil conservation measures related to production adjustment contribute in substantial degree to nearly all crop and intensive pasture land in the United States. A more intensive approach is required for the purpose of arresting decline on the more rapidly deteriorating lands of the country, which include a lesser but still large proportion of all crop and intensive pasture land. A very intensive approach is required where serious flood damages resulting from excessive run-off and erosion accompany damages to upstream lands.

It is hoped that ultimately there will be conservational management of all lands, public and private, including treatment of such character and intensity as varying conditions demand and the eventual use of all land in accordance with its needs and adaptabilities.

In order to accomplish this aim, it will be necessary to enlist the active cooperation of all users of land upon which there is any need for conservation. This, in turn, will require the help of many agencies of government—Federal, State, and local—as well as that of all institutions, groups, and individuals who play a part in molding public attitudes and action. Every effort must be made to encourage the organization among and by farmers themselves of local agencies for the purpose of carrying conservation directly to the land.

It must further be realized that soil conservation is intimately related to broader activities. It can be accomplished only as parallel endeavors succeed. Education concerning good conservation practices, effective land use regulations, provisions for satisfactory tenure, provision of adequate credit, assurance of stable farm prices, and an adequate market for farm products, are all important phases of a composite program of which soil conservation must be a part.

Soil conservation, erosion prevention, and run-off retardation activities represent one major avenue for maintaining and improving the Nation's agricultural productive capacity and resource base—one major avenue for meeting the increasing consumption needs that appear to lie ahead.

A Potential Program

A rough indication of the possible magnitudes of a program for soil conservation, erosion control, and run-off retardation can be obtained from data presented in the 1938 Yearbook of Agriculture and supplemented by recent inventories by the Department's Soil Conservation Service.

In a 1938 Yearbook[1] article, there are given the results of a Nation-wide appraisal by Federal and State agricultural workers concerning the amount of land in the United States suitable for cultivation from the standpoint of erosion and soil losses. It is stated that:

> The objective was of a twofold nature—(1) to determine the amount of land in the United States, exclusive of possessions and territories, that is suitable for cultivation under prevailing price levels during the period 1921 to 1936 and is not subject to erosion injury under present methods of farming, and (2) to determine the amount of land that would be suitable for cultivation, assuming the same price levels, without erosion injury, if the best farming practices and erosion control methods were put into effect. In making the estimates, it was assumed that price levels for farm crops and livestock and costs of production would be about the same as those prevailing during the period 1921 to 1936.[2]

The 1935 census of agriculture gave the cropland area of the United States, including "crop failures" and "cropland idle or fallow" as 415,000,000 acres. Of this, the Yearbook estimates indicated that 161,000,000, or about 39 percent, could be expected to yield satisfactory returns and be cultivated safely under practices then current. "This area would include those soil types that are not susceptible to appreciable erosion, the smooth portion of other soil types and that soil whereon good rotations and other practices are providing erosion preventives." The remaining 61 percent of the cropland, or 254,000,000 acres, was indicated as unsuited to cultivation under current practices and the price levels assumed. It was indicated, however, that 178,000,000, out of the 254,000,000 acres, could be safely cultivated and would give adequate returns at price levels assumed if good soil conservation and farm management practices were followed. It was thus indicated that a total of 339,000,000 acres, or 82 percent of all cropland, were suitable for cultivation with appropriate practices and would yield adequate returns at the price levels assumed.

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[1] See article by E. J. Utz, Charles E. Kellogg, E. H. Reed, J. H. Stallings, and E. N. Munns, pages 84–110.

[2] Ibid, pages 92–94.

Another 76,000,000 acres, or 18 percent of all cropland, were described as land which could not both safely and profitably be cultivated at 1921–36 price levels.

Many types of practices may be incorporated into the normal cropping and land handling practices carried on by individual farmers without any material additional input of labor or equipment cost above the normal farm operating outlays. The only cost, therefore, associated with such practices is the cost of technical services in instructing and demonstrating to the farmers how to carry on the operations. Such practices may be exemplified by good crop rotations, strip cropping, green manuring, use of crop residues, use of seasonal cover crops, etc. For purposes of perspective concerning the magnitude of a program, it may be assumed that on the best 161,000,000 acres of cropland such practices will be applied and that only technical assistance is required.

Such practices are also an essential part of a well-rounded program of conservation and run-off retardation on the remaining cropland; but on this, additional practices are necessary which require substantial inputs for labor and materials outside of the normal farm operating outlays. Planting materials, suitable equipment, and appreciable amounts of labor are necessary for the installation of such practices, a considerable part of which must be made available from off-farm sources even if the farmer financially is able to pay for such facilities. In many major agricultural areas, such practices are needed upon lands operated by farmers whose economic circumstances are such that they have little or no resources from which to make such expenditures. These types of practices would bulk large in a rural works program for this field.

An effective program of erosion control and run-off retardation in any area or upon any farm involves the adoption of a carefully devised and comprehensive plan of land use and land treatment. This calls for mapping individual farms, working out coordinated plans for the application of conservation measures, and exercise of extreme care based upon definite technical knowledge in the execution of those plans. It is essential, therefore, that adequate technical supervision be provided in all phases of the work.

Aside from the technical supervision necessary, experience has shown that the public provision of other facilities, in the form of materials, equipment, and labor, is often necessary. Various types of equipment not available locally may be needed in many areas in order to assist farmers in carrying out the installation of erosion control and run-off retardation practices. Such equipment, for example, may be used for contour furrowing, listing, terracing, gully filling and planting, construction of small dams, etc. Likewise, many of the needed practices involve such amounts and types of labor that the farmer and his family and help can either not supply it at all or only over such a long period of time that soil deterioration will not be halted in time to save the land.

The rate at which a soil conservation program is carried forward is a factor in determining the amount of contribution that can be made by an individual farm owner or operator toward the application of conservation practices upon his land. In view of the fact that the farmers normally have surplus labor and capital available only in small amounts currently, they are able, without aid, to add to their capital improvements, such as the installation of certain conservation practices, only slowly. Therefore, the shorter the time necessary to have conservation practices installed, the smaller the proportion of the costs of such practices which can be borne by the farmers themselves. Many critical areas in the United States, however, must have conservation practices installed quickly in order to prevent complete abandonment of farm land for crop and pasture purposes and the complete economic collapse of the area. Such areas have already gone a long way downhill. It is of major importance that, where possible, the agricultural resources of such areas be stabilized and rehabilitated.

Intensive-use Pasture Lands

The acreage of intensive-use pasture lands in the United States is difficult to estimate. Rough data suggest it to be approximately 175,000,000 acres. From the standpoint of land productivity, much of such pasture lands compares favorably with cropland and in many areas is very intensive in use. In the subhumid and humid areas of the country pasture production is the foundation upon which certain major farm enterprises are based. The productivity of such pastures determines the eventual economic stability of such enterprises, and also determines the earning capacity of the landowners and operators depending upon these enterprises for a livelihood.

Traditionally, farming in the United States east of the Great Plains has centered around crop production, with pasture production in general being of minor consideration. The result has been widespread neglect of pasture lands. Lands which were temporarily or permanently stripped of their productivity through soil-depleting cropping systems and soil erosion, were left idle, perhaps eventually to become pasture land through natural seeding processes. Only in relatively recent years has it been generally realized that the land devoted to pasture on the farms could be made highly productive through the application of soil and water conservation practices and good management.

Since in the past pasture lands have been considered of secondary importance to cropland in the thinking of the majority of farmers, such areas, especially in those agricultural regions having a restricted amount of good land, have been allowed to deteriorate to the point where the cover depletion has resulted in serious soil erosion damage and gullying. Accompanying this erosion damage and gullying has been the displacement of desirable grass species with weeds and undesirable grasses. In view of the fact that a good sod cover on land is very effective in preventing soil erosion and soil depletion and also can be made of major importance in the productive capacity of the farm as a whole, the rehabilitation of pasture lands is a necessary and desirable corollary to the application of erosion control and run-off retardation practices upon crop lands of the United States. As a rule, the inputs necessary for the rehabilitation of pasture lands are considerably less per unit of land than those required for croplands, and the continued success of such rehabilitation, namely, through contour furrowing, gully control, application of lime and fertilizers, and reseeding, primarily depends upon wise pasture management exercised in normal farm operations. In certain areas, however, soil erosion and gullying, and the attendant cover depletion, have reached such a critical state that major inputs, especially in the way of gully control, reseeding, and the application of soil amendments, are necessary to restore the pasture lands to a reasonable level of productivity and thereby bring about economic stability of farm units as a whole.

It is likely that 85 percent of the estimated 175,000,000 acres of intensive-use pasture lands in the United States needs soil erosion and run-off retardation treatment of one type or another. At least 35 percent of this total pasture acreage requires intensive treatment involving relatively high inputs in the way of labor, equipment, and materials.

Long-range Estimates

Table 1 indicates the total amount of work, other than that which may be carried on as a part of regular farming operations and other than technical assistance, which it has been estimated would be necessary to achieve full control of soil erosion and run-off retardation. The column headed "Practices" indicates the types of work involved.

The proportion of this program that can be carried out and the rate at which it can be carried out depend considerably on the extent to which public assistance is considered in the public interest and is provided. The landowners and operators can carry out a considerable portion with no public assistance other than adequate technical supervision. It is likely, however, that more public benefits can be achieved if, from the beginning of operations on a given area or individual farm, the public through appropriate Federal, State, or local agencies, makes its assistance available. This arrangement permits the farmers to do those things which they are most capable of carrying out and gives maximum benefits from the early completion of the total job. Those specific types of practices listed in table 1 are all of a kind which it is not expected that either the farmers or the public should carry out alone. On the contrary, to obtain the needed public benefits, the identical types of work may be carried out by both; however, for the most part, the timing of their completion is the important consideration, plus the additional fact that in several instances an appreciable amount of the work is of such nature and would have to be applied under such conditions that without public expenditures it could not be undertaken by the individual farmers upon whose lands the public interest may require that it be done.

TABLE 1.—*Tentative estimates of soil conservation, erosion control, and run-off retardation undertakings needed on cropland and intensive-use pasture by practices, amounts, and labor required*[1]

Practices	Applicable descriptive unit					Man days required
	Acres	Number	Rods	Miles	Cubic yards	
						1,000's
Water disposal:						
Terraces	85,820,000					75,874
Field diversions	11,887,000					4,295
Drainageways	8,490,000					5,270
Water conservation:						
Terraces	59,189,000					52,969
Contour furrows	36,105,000					5,554
Stock water:						
Ponds		1,024,000				154,839
Springs		380,000				24,392
Wells		37,000				6,469
Planting	594,000					457
Fencing:						
Cutting posts		523,624,000				17,442
Construction				1,892,000		288,694
Conservation preparation:						
Fence or line clearing				637,000		32,914
Pasture clearing	17,506,000					18,936
Conservation planting:						
Critical slopes	14,918,000					13,442
Pastures	50,390,000					33,584
Gully control:						
Diversions			31,615,000			18,512
Structures		7,722,000				25,789
Planting	2,582,000					1,723
Stream bank improvement:						
Structures			8,189,000			11,917
Planting	658,000					438
Rock work:						
Quarrying					160,164,000	160,164
Processing lime					160,164,000	66,005
Total						1,019,679

[1] This table includes estimates for work on land believed suitable for cultivation (land now in brush or timber or available through irrigation or drainage) though not now so used.

Area Considerations

Considering the various major agricultural regions in the United States, it is realized that the amount of help in the way of labor necessary to accomplish the erosion control and run-off retardation objectives will vary according to (1) the resources of the individual farmers, and (2) the nature of the conservation problem presented. In certain agricultural areas farm

owners and operators may have nearly adequate resources for the incorporation of conservation practices and require little more than help in the way of technical guidance. In many of such areas the conservation problem is not critical. In other major agricultural areas the problem of erosion control and run-off retardation has reached such a critical state that a maximum amount of public assistance is justified in bringing about economic and social stability through the stabilization of the crop and pasture resources of the area. Unfortunately, in such areas the ability of the landowners and operators to make substantial contributions to the program is definitely limited because of low incomes. The conservation objective involves the greatest cost in those areas where conservation and erosion control are needed most and the landowners and operators are the least capable, relatively speaking, of carrying the burden of such costs.

Coordinated Approach Necessary

It cannot be stressed too often that to carry out a soil-erosion-control and soil-conservation program in the most practical and beneficial manner on an area or individual farm, there should be a coordinated approach in the application of all desirable practices. For example, a terracing program alone on cropland areas cannot be substituted in any sense for a well-rounded program that embodies as well appropriate practices where needed, such as contour cultivation, strip cropping, crop rotations, winter cover crops, adequate water disposal outlets, gully control and stream bank work. All these where applicable have an erosion-control and soil-conservation benefit, when supplementing each other, that allows for most efficient benefits from inputs. In fact, the proper timing of installation of the various practices which go together to make the complete job is not only one very important key to the degree of erosion control and amount of soil conservation accomplished, but in many cases it is the major justification for public assistance where labor and equipment beyond the reach of the individual landowners and operators are involved.

Special Flood Control and Soil-Saving Structures

There are many watersheds in the United States in which the problems of erosion, siltation, and flooding are beyond control by individual land owners and operators working alone. The normal functioning of practices for erosion control and run-off retardation upon farm and ranch lands tend to reduce materially the volume of run-off from such lands, therefore contributing definitely to the alleviation of flood and siltation damages downstream. However, in many areas special structures, supplementary to the normal erosion control and run-off retardation practices maintained upon farm lands, are necessary to bring about optimum public benefits from the control of floods and siltation. The installation of these special types of water-detention and silt-retention structures, such as small dams, dikes, levees, etc., involves, in a major degree, the public interest and public benefits. Such structures are, by their nature and effect, supplemental to any major flood-control dams and structures located upon downstream waters.

In many local areas special flood-control structures are of high priority in the prevention of serious recurrent flood, erosion, and siltation damages which are not alleviated by major downstream flood-control structures; also, such structures may be the limiting factor in effective erosion-control practices on adjacent farm lands. For example, one or more of such water or soil retention structures, with supporting plantings, may be needed to stabilize an area of large, active gullies running through a number of farms. No one farmer can justly bear the full costs of this special work which involves the "community" type of approach. Adjoining farms affected by excessive run-off and siltation from such gullied areas cannot effectuate a sound soil-erosion control and conservation program because of the uncontrolled run-off from such areas.

Preliminary estimates indicate that for the United States as a whole, approximately 125 million man-days of labor would be required to install such needed structures upon the crop and intensive-use pasture lands.

Public Land Acquisition

Though this statement is not primarily concerned with public land acquisition, it may be observed, parenthetically, that a rounded program for soil conservation, erosion control, and run-off retardation would require the public acquisition of submarginal agricultural lands.

In many areas a considerable acreage of land is devoted to the growing of cultivated crops that is unsuitable for cultivation because of natural infertility, unfavorable climatic conditions, or loss of productivity by erosion. The continued cropping of lands unsuitable for cultivation results in further destruction of the soil resources and may affect the value of other, and frequently more valuable, lands. The families attempting to make a living from such lands generally have insufficient resources to carry on a soil-conservation program on their farms. They are usually unable to make the shift to proper land use; for instance, from cash-crop farming to grazing, and still secure a living from their farms. Many of the families are "stranded" in their present locations; there is no market for their properties; they do not have the resources to relocate elsewhere; and as a result, many continue to reside on

their farms as long as they can eke out an existence. A substantial proportion of families occupying submarginal farms receive public assistance in the form of cash, goods, or work relief. Housing conditions are usually pitifully poor, the families are improperly fed and poorly clothed, and the frequency of illness and physical disability is abnormally high.

The primary need with respect to such land areas is an adjustment in land use and of people to resources. Such adjustments should precede any extensive conservation works program.

It has been pointed out in a recent publication of the National Resources Planning Board [3] that public acquisition is often a key step without which essential shifts in land use cannot be brought about. It is, therefore, often a key step in a program of public works.

In some instances large blocks need to be acquired and shifted to less intensive uses. It is often possible, however, through the acquisition of relatively small acreages, so to change the pattern of land use and occupancy as to enable a substantial proportion of the families to build up operating units capable of supporting a family after allowing for soil maintenance. Land may be acquired from farming units with little possibility for rehabilitation and added, through resale or lease, to other potentially adequate units.

Public acquisition may be viewed as one of a kit of tools for facilitating land-use adjustment. It is believed, however, that it should only be used when adjustments cannot be achieved as effectively by other means alone.

Evaluation Considerations and Principles

Relationship to General Objectives and Plans

In approaching the evaluation of specific works and projects in the general field of soil conservation, erosion control, and run-off retardation, the objectives and setting of public land use activities generally, the general objectives and setting of these types of work, and the general nature, qualitatively and quantitatively, of a potential program discussed above, should be borne in mind. These form the background for evaluating specific projects. It may here be emphasized that a program for these types of work should be consistent with: (a) Other programs for agricultural land use, (b) programs for other types of land, such as grazing, forest, and recreational land, and (c) area programs generally. It follows that specific soil conservation, erosion control, and run-off retardation projects should also be consistent with these broader programs.

[3] *"Public Land Acquisition in a National Land-Use Program,* Part I: Rural Lands", June 1940.

Comparison of Costs and Benefits

It is axiomatic that a specific proposal for soil conservation or related activities should promise total benefits greater than total costs. The difficulties of measuring all costs and all benefits are so great, however, that this criterion must be tempered with a great deal of general judgment.

Multiple Purpose Works.—The measures and practices for soil conservation, erosion control, and run-off retardation are generally multiple purpose in character. The general measures such as cover-cropping and green manuring, for instance, contribute to fertility as well as to erosion prevention and run-off retardation. The practices suggested in table 1 are also largely of a multiple purpose character. Their more immediate as well as their future benefits do not accrue entirely to lands upon which the practices are undertaken. Even when these practices are undertaken primarily for the purpose of improving the lands upon which they are carried out, nearby lands tend to receive incidental benefits. Where there are serious problems of flooding and siltation in the lower reaches of watersheds and land treatment is carried on with the dual purpose of erosion control and flood reduction in mind, it is clearly necessary to recognize the "offsite" benefits as well as the benefits to the land treated. Special flood control structures are designed primarily for downstream protection; but even these usually result in incidental benefits to upstream lands.

In general, measures which accomplish soil and moisture conservation, such as terracing, cover-cropping, contour furrowing, etc., also serve the purpose of helping prevent excessive run-off and flooding of the lower reaches of watersheds, though it must be recognized that the existence of a serious flood control problem requires usually more intensive, and often different, practices and works than if such a flood problem did not exist. Where agricultural conservation treatments serve a dual purpose, it is warranted that they be undertaken at a rate and intensity which is greater than if there were no downstream benefits.

Widespread Benefits.—The widespread incidence of benefits from measures for soil conservation, erosion prevention, and run-off retardation contribute to the difficulties of measuring them with precision. The direct benefits in terms of increased future income to lands directly benefited can be roughly calculated and discounted; although even this involves uncertainties. The interest which society has in maintaining the Nation's agricultural land for the future appears to warrant a relatively low rate of discount. It should be noted, however, that a slight variation in the interest rate used to discount future benefits can alter the cost-benefit ratios considerably. The indirect bene-

fits to neighboring lands and to nearby towns and cities are extremely difficult to appraise and the widely diffused social benefits of preserving land for posterity must evidently be a matter of general social philosophy and judgment.

Successive Approximations Suggested.—It is believed desirable to approach the determination of total benefits from soil conservation and related activities in two main steps. An attempt should be made to calculate the direct benefits of works in this general field even though it is realized that such calculations can only serve as a partial basis for judging their full benefits. As a second step, it will normally be necessary to arrive at the proper proportion of indirect and intangible benefits to allow. To a large extent the decision for particular projects will probably have to be made by reference to the tolerance for general types of activity as indicated by previous legislation and current public opinion. In general, a large ratio of calculable benefits to costs should be considered a favorable factor in evaluation.

Project Definition Important.—The problem of evaluating works in this general field is further complicated by the fact that the benefits tend to be a product of several practices jointly. Effective erosion control and run-off retardation normally involves a combination of coordinated practices. Specific practices cannot, therefore, be evaluated singly. They must be placed, for intelligent evaluation, in the general setting of a coordinated program for a given area. If appropriate areas can be determined and viewed as "projects" for evaluation, it seems that reasonable judgments concerning direct costs and benefits could be made.

Sharing the Costs

A large proportion of all works for conservation, erosion control, and run-off retardation on cropland and intensively used pasture takes place on private land; and the nature of the arrangements for sharing the costs is an important consideration in determining the desirability of specific proposals. In general, costs should be shared among individuals and government in rough proportion to benefits except in cases where individuals or groups cannot, under such an arrangement for sharing the costs, undertake activities that should be undertaken in the national interest. Often, in the interest of economic reconstruction and employment stabilization, the Federal Government may be justified in bearing more than its proportion of the costs up to the limit of broad social benefits. The lack of criteria and techniques for the precise measurement and allocations of indirect, intangible, and broad social benefits makes it necessary to resort to general judgments when attempting to apply the above principle in the evaluation of specific proposals.

A large contribution by benefiting individuals, relative to the usual contribution for similar projects, would normally be a favorable characteristic. There may, however, be cases in which a project proposing a relatively small contribution, such as one designed to rehabilitate depressed groups or communities, should be given a favorable rating.

Financial arrangements which recognize the indirect benefits of soil conservation and run-off retardation activities to nearby areas and communities, as well as to the lands benefiting directly, by providing for some contribution by local governments, should be viewed with favor.

Institutional Arrangements.—The difficulty of measuring precisely the public or general social interest of public works in this field, and the difficulty, therefore, of determining the proportion of the total cost that should be borne by the various levels of government, emphasizes the need for adequate institutional arrangements to assure that the public benefits contemplated, when any proportion of public aid is given, will actually be achieved. Where soil conservation districts, other local units of government, or cooperative groups exist, there is a possibility of continuity of action and social control over nonconforming individuals. Very often such organized groups can develop legislative action and land-use regulations necessary to promote conservation and wise land use. It is always important that Federal aid be accompanied by adequate arrangements for assuring continued action in the public interest; but it is especially important in the situations in which the Federal Government assumes an exceptionally large responsibility for bearing the costs. In such situations, organization for effective use of Federal aid and development of appropriate regulations may serve as something of a substitute for a larger local contribution.

The problem of financial arrangements for desirable conservational activities on agricultural land becomes somewhat simplified when the land upon which they are to take place is publicly owned. The public ownership of land requiring rehabilitation, development, or adjustment provides the possibility of adequate control. The rebuilding of land submarginal for agriculture is often possible only if the land is first brought into public ownership. Actually to accomplish the desired land-use objectives, land publicly acquired must, of course, be properly managed.

Application to Table 1.—In considering the proper sharing of the costs of practices mentioned in table 1, the following factors should also be kept in mind. First, the individual operator is expected to perform such practices as strip cropping, proper rotation, and

cover cropping in addition to doing his share on the special practices mentioned. Second, the ability of most of the farmers whose lands require special practices to pay for those practices is relatively low. Third, the proportion of the total cost that the farm operator can contribute tends to be greater as the period of time taken for completing the job increases. A longer period of time enables him to make more use of his own labor and facilities.

Timing

The fact that the proportion of the cost that can be borne by the farm operator tends to vary inversely with the rate at which the work is carried out should be kept in mind when considering the timing of a program of rural works in this field. It must also be recognized that the deterioration of much of the land requiring such works has been extensive and that a program which would arrest this deterioration must move rapidly. For maximum effectiveness in restoring many millions of acres of land to a maintenance basis, the program would have to be undertaken at a faster pace than would be possible if financed entirely by private operators.

In order to realize maximum employment stabilization, it would be desirable to carry the program forward at a more rapid rate during periods of unemployment than during periods of prosperity. A program in this field can be planned and could be executed in this flexible manner. Depending upon the employment needs and the public contribution, it is believed that resource restoration could be effectively achieved if such a program as was suggested above could be completed in from 10 to 20 years.

3. LAND DEVELOPMENT AND SETTLEMENT

General Setting

It has long been pointed out that the long-run outlook is for an increase in demand for farm products. It has been recognized earlier in this paper that new knowledge and technological advance may go far toward meeting this need for additional land products and that a program of soil conservation, erosion control, and run-off retardation may contribute extensively to meeting the increased need by improving the productive capacity of land now in use. Land development, however, offers a more obvious means of creating additional productive capacity and support for population. The development of new areas for settlement offers also the possibility of developing additional ownership units and opportunities for people to obtain family farms. This may warrant special attention to new land settlement even at some sacrifice of the net physical product per dollar invested by the Nation. If special recognition is given to this factor, however, it should be certain that new lands are settled under conditions and arrangements that channel the benefits and opportunities to needy families rather than to speculators. The program of land development should, of course, be correlated with a program for rehabilitating or shifting to less intensive use inferior lands now in cultivation.

Land is now developed for agricultural use mainly through clearing, drainage, and irrigation; and often two or more of these activities must be performed on the same land. Flood control, as in the Mississippi Delta, also contributes extensively to making additional land available for agriculture.

The bringing of new land into production involves much more than clearing, drainage, or irrigation. It normally requires additional land improvements such as land leveling, and homes, fences, and other farm facilities. It also requires various community facilities.

It may be helpful for some purposes to distinguish the problems of land development on farms already settled from the problems of its development in new areas. Land development in existing drainage enterprises, existing irrigation enterprises, and on existing farms generally neither offers as much opportunity to provide new ownership units nor presents the problems of aiding and guiding families in the settlement of such units.

Land Settlement

The major problems involved in the settlement of new lands relate to the size of the individual farm unit, stability of tenure, credit including conditions of repayment, and settler guidance.

A great deal of the land in the United States has been occupied through homesteading. Experience shows that much of the lands which were given to individuals virtually free of charge two or three decades ago has been lost through bankruptcy by the original owners. The social cost of this change in ownership of land has been tremendous. This instability has been a partial basis of the aimless migrations which have taken place in the Western States during the past decade or two.

The size of unit necessary for a family is extremely important. The original homesteads in nonirrigated subhumid and semiarid areas were often far too small, and the United States is now paying the penalty for this earlier policy.

The matter of credit also is an important problem in settlement and in providing stability of tenure. Too much credit has been available in some periods and in some areas, but the cost and terms generally have been prohibitive or destructive for the average farmer on new lands. A sound settlement policy, therefore, must take account of the mistakes of the past and must be based upon sound unit subdivision and sound financing policies.

The Government may contribute to the settlement of new lands in different ways. The Government may acquire the lands to be developed and may prepare these lands for settlement, including construction of necessary improvements. These units then may be leased to an individual indefinitely, or leased during a development period and later sold, or they may be sold immediately upon completion. The Government may acquire the land and immediately sell it to an individual and let him provide the necessary improvements. The land may be purchased by the Government, leased to a cooperative association, and subleased by this association to individual settlers after improvements have been provided. A number of variations of the above may be possible.

Newly developed lands should be used in such a way that their influence may radiate as far as possible. For example, in the West the development of irrigated land should be part of a total area program. Such an area program should contemplate the settlement of the lands largely by dry-land operators from the surrounding territory. Not only can these relocated dry-land operators be rehabilitated, but their vacated holdings can be added to the under-sized units of remaining dry-land operators, thereby rehabilitating

them also. Lands suitable only for grazing should be integrated with irrigable lands.

A total area program, carefully conceived and carried out, will provide the best possible total resource development and insure low future social costs. A well worked out pattern of settlement, not only on the newly developed lands but also in the other areas affected, will reduce the cost of maintaining the necessary institutions and services. In every case of new land development and settlement, the aim must be to develop a sound total area economy and to have the newly developed land an integral and basic part of the total area.

Careful study of possibilities and requirements for successful settlement should be made in each area and adequate information concerning these should be provided prospective settlers. Prospective settlers need also to be advised concerning their personal fitness for the type of farming contemplated. The cost of guided settlement is far less over a period of years than the cost of unguided settlement. The latter has cost billions of dollars in Federal, State, and county relief expenditures, to say nothing of the strain on the social and economic structure generally. With a sound program of financing and development of new lands, many of these difficulties of the past may be avoided.

Irrigation and Other Water Utilization Activities

Objectives and Setting

Irrigation and water utilization provide a major means of improving the capacity of land resources for supporting population in the arid and semiarid portions of the 17 Western States. In these areas water conservation is a vital element of stabilization.

The general objectives of the irrigation development and water and land utilization program are the creation, rehabilitation and maintenance of self-sustaining agricultural communities in the arid and semiarid regions of the western third of the United States. The construction as public works of irrigation projects, in which employment is combined with maximum conservation and utilization of land and water resources, contributes to the achievement of the central aim of a national land-use policy.

The production of more food is a pressing wartime need. Irrigation projects previously developed are contributing to this need. Irrigated farms, with their capacity for high yields of alfalfa and their ability to provide high quality pasturage are contributing significantly to meeting the need for dairy products. Much-needed fruits and vegetables are being supplied by irrigated land. The completion of certain projects now under way can contribute to the food requirements of the relatively near future. For instance, completion of the Central Valley project, under the direction of the Bureau of Reclamation, will insure supplemental water supplies for, or otherwise protect, about 2,000,000 acres of irrigated land in the inland valleys of California. Some of this area can be served in a relatively short time, although the bulk of the acreage will not be benefited for about 5 years.

Closely linked with irrigation developments to increase the Nation's food supply is the expansion of hydroelectric power facilities in multiple-purpose projects. The urgency of the demand for power on the Pacific coast and in the Intermountain region to serve industries producing airplanes, warships, and munitions, gives it precedence even over increased food production requirements. However, since all of the multiple purpose projects will store water for irrigation, the contributions they make to food production in the emergency, and settlement opportunities in the post-war period are of great importance.

The Colorado-Big Thompson project will bring relief in the form of supplemental water to 1,000,000 acres of land in the Northern Colorado Conservancy District of Colorado. Power is paying for part of the costs. The Columbia Basin project in south-central Washington, ultimately creating 1,200,000 acres of newly irrigated land, could not be built without the aid of power revenues. This power is now not only an indispensable aid to irrigation, but a tremendously valuable contribution to the power needs of the war program. The story is repeated in the Central Valley project of California, where much-needed supplemental irrigation water is to be made available through construction that is made feasible by anticipated power revenues.

Even though all effort must be effectively directed toward the immediate goal of winning the war, detailed economic and social planning designed to expedite "shifting gears" from war to peace cannot be delayed. The problems of unemployment and social readjustment which will follow the war may be an ultimate test of our economic structure. Inclusion of irrigation construction work in a public works program for the future will achieve the twofold purpose of carrying on the reclamation program for the West and of providing employment both on and off the site of construction.

Of far greater importance in the post-war period, however, will be the need for establishing a domestic economy that aside from the employment benefits from construction of public works, will insure a continuing flow of goods from and to the western States. The creation of agricultural opportunity through water conservation and irrigation is the foundation for sound western economy and, in turn, for the West's contribution to the national economy.

Area Situations

The situation with respect to land use for agriculture and settlement in the arid and semiarid regions west of the 100th meridian revolves around the water resources that can be economically conserved and used for irrigation. East of the 100th meridian the rainfall generally exceeds 20 inches annually and is sufficient for crop production. West of that line, except for a narrow strip along the northern Pacific coast and in the high mountains, the rainfall generally is less than 20 inches, insufficient for normal crop production, especially since the seasonal distribution does not provide adequate moisture during the growing season.

In this western arid and semiarid section are 153,600,000 acres of land, which on the average receive less than 10 inches of rain a year. Of the remaining area, 588,700,000 acres receive from 10 to 20 inches annually. Thus a total of 39 percent of the land area of the United States receives too little rainfall for safe general agriculture unless water can be supplied artificially by irrigation. Instability, migration, and large relief loads have characterized these western areas in recent years.

The area where the conservation of water for irrigation is the predominant need covers in whole or in part the 17 far-western States. For the purposes of this presentation, the area will be further broken down into the Great Plains, the Intermountain Region, and the Pacific Coast States. The Great Plains, both northern and southern sections, lie generally west of the 100th meridian and generally east of the Continental Divide and the Pecos River. For the purposes of this report the lower Rio Grande Valley of Texas is included in the Great Plains region. The Intermountain region extends westerly from the Great Plains to the borders of the Pacific Coast States of Washington, Oregon, and California. In the three regions there is a differentiation in the problems, objectives, and possible accomplishments so far as an irrigation development and water and land utilization program is concerned.

The Pacific Coast States.—During the 1930–40 decade the population of the far-western States grew at a rate twice the national level. The largest increases proportionately, except for those in southern California, were in the towns and cities dependent on irrigated areas and were due to migrations from the Great Plains and other regions. Of more than 350,000 families which migrated into the 11 Mountain and Pacific States, nearly half had agricultural backgrounds. Most of them sought opportunities to return to the land.

From 1930–40 more than 30,000 migrant families concentrated in the San Joaquin Valley of California, which has been affected by irrigation water shortages. It was necessary for the Federal Government to set up in California alone 13 fixed and 5 mobile labor camps to care partially for the many people who have fled to that State.

The Great Plains.—A series of wet years during the first two decades of the twentieth century and the spur of wartime prices for wheat led to over-settlement of the Great Plains. When the drought of the 30's came, its impact on the land and people of this area was staggering. The great dust storms of 1934 brought a realization that the agriculture of this region was out of balance with nature and that major land-use readjustments were overdue. The uprooting from 1930 to 1940 of 350,000 farm and other families in the Great Plains, due in a large measure to drought, had its repercussions in the pressure of population on the presently developed land resources in the irrigation States to the westward. These States without irrigated land available for settlement were naturally not prepared to receive the newcomers who fled the drought of the last decade.

For the past three decades crop failures in the Great Plains have occurred in about 1 out of every 3 to 7 years, depending upon the particular area involved. Good yields have occurred about once in every 5 years. Crop returns and farm income have been correspondingly erratic.

In 1934, from 25 to 73 percent of the farmers' income in the Great Plains came from public assistance. In each year since 1930, the proportion has varied among areas, but has been very material. For example, in 1939, the figures ranged from about 7 percent in Wyoming and Colorado to about 20 percent in North Dakota.

Tax delinquency has been very severe in all Plains States. The delinquency in North Dakota for 1933–38 was over 22 percent. Three counties in Texas had up to 40 percent of their total land area delinquent in 1935. In one county in Colorado, over 30 percent of the farm land was sold for taxes between 1934 and 1937.

The Intermountain Region.—Drought and inadequate irrigation water supplies have seriously affected crop production and range lands in the Intermountain region. Rainfall in most of this area is even much lower than in the Great Plains; hence water shortages create serious economic and social problems.

The average increase in the population of the Intermountain region in the 1930–40 decade, primarily due to migrations of people from the Great Plains seeking new opportunities, was 11.5 percent. Since this area already was overcrowded, new opportunities for employment would need to be developed if an adequate living were to be available to the additional population. Federal relief expenditures through the Work Projects Administration and its predecessors in 7 years

totaled more than $545,000,000 in the Intermountain area.

In summary the West offers a paradox of instability and opportunity. In this situation irrigation and water utilization stand out as a means for increasing both stability and opportunity. Some migration is undoubtedly desirable and the relief situation in the western States during recent years must be recognized as part of a general situation of depression and unemployment during the 1930–40 decade. In part, the additional population in the coast States and Intermountain area is now being absorbed by industry, but cessation of the war will bring new problems of unemployment. Industry must absorb a large portion of those who wish employment in the future, but new land in agriculture can also play an important part. Although certain areas, especially in the Great Plains, are oversettled, future years will probably see a need in the West for both additional population support and for helping many families already settled to remain in place. To the extent that opportunities for new families can be created and the condition of others improved, the possibilities of development through irrigation merit careful consideration.

Participation of Federal Agencies

Practically the only irrigation development now underway is being carried on by Federal agencies. Up to 1902, private capital had brought some 9,000,000 acres of land under irrigation. The Federal Government entered the field through the Bureau of Reclamation. Since 1920, practically all irrigation project developments have been through the Bureau of Reclamation and the Office of Indian Affairs of the Department of the Interior.

Legislation in recent years has brought the Department of Agriculture more fully into the western resource development program through the land purchase, development, and settlement phases connected with the Water Conservation and Utilization Program (Wheeler-Case Act) and the water facilities program. The Corps of Engineers of the War Department has built storage dams, primarily for flood control and navigation purposes, but which in some instances provide water storage for irrigation projects. The Public Works Administration has provided loans and grants for the construction of irrigation works largely by Federal agencies. The Office of Indian Affairs develops projects on Indian reservations. The Work Projects Administration provides labor and some materials for construction of irrigation works under Federal or local sponsorship. With the Civilian Conservation Corps,[1] the Work Projects Administration contributes to the rehabilitation and improvement of existing irrigation systems. Both of these agencies are factors in advancing the Federally sponsored projects under the Water Conservation and Utilization Program.

Projects constructed under the Reclamation Act consist primarily of those designed to irrigate new land or provide supplemental water for areas inadequately irrigated by other systems. These projects, however, frequently include other purposes such as power for pumping, industrial and commercial purposes; water for municipal supplies; flood control; navigation improvement; silt and pollution control; river regulation; recreation; and wildlife refuges.

The Water Conservation and Utilization Program is being developed in established agricultural areas in the Great Plains and to the westward where irrigation is highly desirable, but where the entire costs may be too high to be repaid by the water users. Existing irrigation systems with depleted water supplies are also rehabilitated under the program. The Bureau of Reclamation constructs the irrigation systems, and pursuant to cooperative agreements with that Bureau, the Department of Agriculture handles land development, settlement, and land-use readjustments.

The water facilities program of the Department of Agriculture involves the construction of irrigation systems for individual farms and small groups of farms involving not to exceed $50,000 of Federal funds for each project; and also provides for domestic and stock-water developments and repair or rehabilitation of existing systems.

Past Developments

Approximately 20,500,000 acres of land are under irrigation in the West according to the census of irrigation of 1940. This is about 3 percent of the area receiving less than 20 inches of rainfall annually and is an area about the size of the State of Maine. Irrigation works have been constructed for the irrigation of about 25,000,000 acres but due to farming practices, failure of water supplies, nonproductive land, or other conditions, only about 75 percent of the area under constructed works is served in any 1 year. By regions, the land actually irrigated by all systems in the West in 1939 (as shown by preliminary 1940 census reports) was approximately as follows:

	Acres
Great Plains (including Lower Rio Grande)	2,300,000
Intermountain	11,900,000
Pacific coast	6,300,000

The Bureau of Reclamation has constructed facilities to provide a full supply of water to 2,500,000 acres of land, and a supplemental supply to about 1,800,000 acres. In 15 States, these projects have created 50,000 farms and support a large additional number of persons in cities and towns. Projects under construction or

[1] Since this was written, Congress has provided for liquidation of the Civilian Conservation Corps.

authorized in 16 States will bring in 2,500,000 additional acres and provide supplemental service for 5,164,674 acres.

The Office of Indian Affairs has provided irrigation works for nearly 10,000 Indian families who farm approximately one-third of the irrigated area. Another third is leased to white farmers, and the remainder is owned by white water users. Approximately 25,000 families (Indian and white) are served by these projects located in 15 States. There are 820,000 acres of Indian land now under constructed works, and 500,000 additional acres that will be brought under irrigation when the current program is completed. Subsistence gardens for Indian families are an important feature of the Indian irrigation program.

Twelve projects involving a total of 133,000 acres have been authorized under the Water Conservation and Utilization Program. It is estimated that approximately 2,000 families on the project farms and in the surrounding dry-land area will be stabilized by these projects, while villages and towns nearby which have been threatened by desolation will receive new stimulation.

Program Possibilities

Preliminary investigations indicate that unused water in the 17 Western States can be conserved to give an assured supply to all lands now irrigated and to reclaim 22,000,000 additional acres. These investigations also indicate that of the 20,500,000 acres now irrigated, there are 11,700,000 acres which will require supplemental water. The distribution by regions has been estimated as follows:

	Great Plains [1]	Intermountain	Pacific coast	Total
	Acres	*Acres*	*Acres*	*Acres*
Area requiring supplemental water	700,000	8,000,000	3,000,000	11,700,000
New area to be irrigated	4,500,000	6,400,000	11,100,000	22,000,000
Total acres involved	5,200,000	14,400,000	14,100,000	33,700,000

[1] These figures include development for 700,000 acres in the Lower Rio Grande Valley of Texas, of which about 70 percent will require supplemental water.

The actual amount of land that can be developed through irrigation is, of course, uncertain. While there is sufficient water to permit development of 22,000,000 acres of new land and to supply supplemental water to 11,700,000 acres of land now in irrigation enterprises, the proportion of the total acreage physically capable of irrigation that will actually be irrigated will depend also on economic feasibility and upon the extent to which public aid to irrigation development is considered desirable and is given.

In the 1934 National Resources Planning Board Report (page 192) it was estimated that of a total of 26,376,000 acres of additional irrigable land in the United States as a whole, 7,114,000 could be irrigated for $100 per acre or less and that 10,330,000 acres could be irrigated for $200 per acre or less. These estimates did not include the costs of land preparation, buildings, etc.

It appears likely that except for small projects mainly on individual farms the great majority of all additional land to be developed through irrigation will require that at least as large a share of the cost be borne by the Government as under the Federal reclamation law. Irrigation costs under the Federal reclamation law are reimbursable in 40 years without interest. Construction costs under the Wheeler-Case Act are similarly reimbursable except that labor and materials contributed by the WPA and CCC are reimbursable only in such amounts as may be determined by the President. It is evident that the magnitude of an irrigation program in future years will depend considerably on the degree to which the Government shares the costs. In determining this, the need for additional population support and the relative effectiveness of irrigation in providing it should bulk large.

In areas where water is available, land may also be developed through the construction of irrigation facilities for individual farm units or small groups of farms where streams, wells, or springs may furnish the necessary water supplies. Much of this acreage is now cultivated under dry farming use and initial irrigation developments on such lands would not necessarily imply new settlement projects and broad scale establishment of new farm units. Such development would provide for a more complete utilization of adjoining range resources by making available supplemental feed supplies for livestock. Eventually some new settlement might come about in certain areas, depending, of course, upon the availability of water supplies, but the first consideration would be directed toward the present users of these lands and the development and maintenance of their interests in this change from the present types of use to fit in with the more intensive use of land through irrigation farming. Several million acres and many farm families could be benefited by this approach. However, the total acreage actually irrigated and the total volume of water used would be relatively small even though a large number of projects of this type were undertaken.

Consistent with the development of these small projects it is, of course, necessary that all such works be based upon sound area and watershed planning which is founded upon the rights and needs of all the users of the watershed lands and waters as well as the down stream areas.

Benefits

If the whole 22,000,000 acres of new land for which water is available in the West could be brought into

production and supplemental supplies provided for 11,700,000 acres now inadequately irrigated, it could provide 60 acres of land for over 366,000 new farm families and an estimated 123,000 farm families would be given added security. A program for the development of even a substantial portion of this acreage would also provide large employment opportunities at the site as well as for workers at distant points who produce raw materials, and process and transport equipment and supplies.

It should be borne in mind that each farm forms a base for economic activity and employment in towns and cities; and a great many families, other than those on farms, receive indirect benefits from land development through irrigation.

Coupled also with the benefits derived directly from irrigation are, in many instances, additional benefits from power production, flood control, provision of water for domestic and industrial uses, stream regulation, furnishing of facilities for recreation, protection of fish and wildlife, abatement of pollution, and reduction of erosion and siltation.

Some irrigation projects now under way can be completed in time to provide critically needed food in the relatively near future, and some multiple purpose projects can be completed in time to provide additional power for war industries.

The employment phase of such irrigation construction as may be soundly undertaken in the post-war period will be a significant contribution to the post-war effort to stabilize employment. The benefits of sound projects do not, however, terminate with construction. Such projects have cumulative benefits and contribute to steady progress in developing the West.

Land Development Through Drainage

Background

In the humid areas of the country the reclamation of wet lands offers considerable possibility for increasing productive capacity and support for population.

Land drainage has had an important part in the development of American agriculture and in the improvement of public health. It is conservatively estimated that more than 100,000,000 acres of fertile land have been added to the cultivable land area in the United States or have been made more productive and profitable by improvements constructed by drainage enterprises. The benefits to health are exceedingly difficult to measure, but it is known from early records that previous to extensive drainage, malaria was generally prevalent in Illinois, Indiana, Michigan, and Ohio and that it is practically unknown in these areas today. The experience in the South also has been that after drainage the extent and seriousness of malaria have been generally diminished.

Drainage of farm lands began soon after the first settlement was made. It was discovered early in the work that even in small undertakings several landowners frequently were interested but that it was often difficult to secure voluntary cooperation. When many landowners were concerned, it was practically impossible to secure unanimous action. This difficulty brought about the passage of laws which provide means of constructing necessary drains and forcing all landowners to pay their just share of the cost. The first drainage law of which there is authentic record was enacted by the colony of New Jersey on September 26, 1772. This act was drawn for the specific purpose of improving the Passaic River. A general drainage act was passed in 1804 in New York State and several other States enacted similar laws at approximately the same time. Under these early acts the work done was small and in many cases was done by the landowners themselves. In all cases it was paid for in cash as the laws made no provision for incurring debts, but simply provided methods for assessing benefits and forcing those benefited to pay a proportionate share of the cost.

As the projects grew in size, expensive machinery was required for economical construction and it became necessary to employ contractors to handle the work. These contractors had to be paid at the completion of the work. As the landowners could not raise the large sums required, drainage development, for a time, awaited legislation which would allow adequate and proper financing. In 1879 Illinois passed its levee and farm-drainage acts, which permitted the district to issue bonds to be sold for cash to pay for the construction. These bonds were first liens on all assessed lands within the district, and arrangements were made whereby the landowners had a long time in which to pay the costs assessed against them and thus redeem the bonds.

Since 1879 practically all of the States have passed laws that have been approved by the courts, by which drainage districts can be established and financed under the supervision of the courts.

Prior to 1910 the organization of drainage districts requiring bond issues was confined primarily to the north central States of Indiana, Ohio, Illinois, Minnesota, Wisconsin, Iowa, and Missouri, with comparatively few districts in the alluvial area of the lower Mississippi Valley. The engineering problems were simple, the cost of drainage low, and the expenses involved in putting the land into cultivation after drainage were small. The work proved very profitable and made possible the development of much of the most fertile and profitable agricultural areas in the States in which the land was located. The development con-

tinued, with few exceptions, on a conservative basis until about 1915, when the agricultural prosperity resulting from World War I led to the speculative development by drainage of cut-over lands and swamp areas during the period of high prices. A considerable number of these areas have encountered financial difficulties during the agricultural depression following 1920. On many of the projects the promoters failed to take into consideration such items as soil fertility, cost of developing farm units after drainage was completed, difficulties in obtaining settlers for the undeveloped areas, cost of maintaining drainage improvements, need for agricultural products to be grown, etc. In some areas the plan of drainage was incomplete or improvements were designed with insufficient capacity so that large areas remained poorly drained and could not be made to produce profitable crops without extensive additional work. In other areas the cost of the drainage was excessive and the landowners found it impossible to meet their drainage assessments from the income received from the land. The extent of these ill-advised projects, while large, is but a small percentage of the area that has been successfully and profitably reclaimed by drainage, and the difficulties that have been encountered should not lead the Nation to ignore the possible benefits to the agriculture of the country in carrying on a constructive development of the wet, swamp, and overflowed lands that still exist throughout the country. Such development should be made a part of sound land-use policies, with proper consideration for wildlife, forestry, and recreational developments.

Since the break in the prices of agricultural products in 1920 and the deflation of land values that occurred at that time, the farmer has had a difficult time. Conditions became especially critical in 1930 when many farmers found it impossible to meet their regular taxes. Landowners even in drainage districts with no outstanding bonds or obligations frequently found it impossible to raise funds to maintain their drainage improvements. Lack of maintenance resulted in poor drainage which reduced crop yields and income and made the raising of funds for maintenance all the more difficult. This vicious circle has resulted in the development of unsatisfactory drainage conditions in many formerly well-drained areas and has reached a stage where extensive rehabilitation of drainage improvements is necessary to restore good drainage.

Districts organized during and immediately following World War I when agricultural prices were abnormally high have faced, in addition to the problem of maintaining their drainage improvements, the problem of meeting the drainage assessments levied to meet the outstanding bonds. In many of the districts only a small part of the land had been brought into cultivation at the time the break in agricultural prices occurred, and these districts have been faced with the impossible problem of paying for high-cost work out of deflated incomes from a fraction of the land drained.

The Government, through the Reconstruction Finance Corporation, has assisted many drainage districts in refinancing outstanding obligations. However, such assistance does not meet the problems of rehabilitating existing drainage improvements, providing increased capacity where necessary, extending improvements to areas unsatisfactorily drained by the original works, developing the nonproductive areas that must meet their share of the drainage assessments, and similar problems. Assistance and guidance in the solving of such problems are essential if many worth-while drainage enterprises are to be developed into financially sound organizations.

Some Federal aid in rehabilitating drainage district improvements has been extended through the CCC and the WPA. The amount of such assistance has been limited by various factors but has been extensive enough to show the great benefits resulting from such work.

While a large majority of the organized drainage enterprises in the country have proved profitable and have resulted in the development of millions of acres of our most valuable agricultural land, there have been sufficient failures to indicate the need for guidance in the planning and carrying out of such enterprises. Many districts have been organized in comparatively small areas, based more on community needs and interest than on watershed requirements. No systematic procedure has been followed. Some districts have good agricultural drainage, the drainage of others is entirely inadequate. Big ditches flow into little ditches which in turn empty into unimproved, badly congested natural channels of sluggish bayous. These adverse situations create confusion and result in hard feelings that perplex and discourage the landowners. The cause in most cases is poor planning and piecemeal methods of drainage. Few districts have employed competent engineers and many have no engineering plans of any kind. In many cases the sizes of ditches are entirely inadequate, with the result that the land has never been drained. Some districts have been unsound projects from their very beginning because the soils were not of sufficient fertility to warrant development, or the lack of control or erosion from surrounding hill lands made it impractical to maintain the drainage improvements.

Such difficulties could have been largely overcome if Federal assistance had been available to the local people in determining the desirability of the project from the land-use point of view, in developing sound engineering plans, and in financing the project on a reimbursable basis.

Drainage Program Possibilities

The rehabilitation of existing drainage enterprises and the drainage of areas of wet, swamp and overflowed lands outside such districts affords an opportunity for the employment of a large amount of unskilled labor. A large part of such work consists of clearing ditch channels, the construction of outlet structures for lateral ditches, preparation for seeding, and the seeding of ditch banks, and similar work that common labor can be used on to good advantage. Most of the excavation would require heavy equipment.

Existing drainage enterprises.—According to the 1930 census, there are approximately 80,000,000 acres of land in organized drainage enterprises in the humid section of the United States. Of this 80,000,000 acres, approximately 54,000,000 acres are under various degrees of cultivation, and about 19,000,000 acres remain in an undeveloped state. The balance is in farmsteads, pastures, etc. Of the 54,000,000 acres in cultivation, approximately 24,600,000 acres require the rehabilitation of the outlet drainage improvements before the land can be used to the best advantage. Of the 19,000,000 acres of undeveloped land, at least 4,300,000 acres are fertile land suitable for cultivation and probably warrant the cost of rehabilitating existing drainage improvements. The cost of such work is estimated at from $5 to $30 per acre with an average of $9 per acre. In considering the estimates in connection with the undeveloped land, it must be remembered that the rehabilitation of the outlet drainage is but a part of the cost of putting the land in shape for farming. A large part of the area is cut-over timber land that must be cleared. Bridges must be constructed to reach inaccessible areas; field ditches are required to supplement the outlet ditches constructed by the district. Where new settlers are involved, the cost of buildings, fences, etc., must be taken into consideration.

The cash cost of clearing the land would not exceed $15 to $20 if the clearing were done gradually by the use of the settler's own labor. If the land were cleared and stumped by contract, however, the cost might run much higher. The cost of roads and bridges varies widely—in some instances no bridges are required while in others the cost may be as high as $3 to $4 per acre. An average cost of $3 per acre for roads and bridges is considered a liberal estimate. The cost of field ditches averages from $2 to $3 per acre. Allowing $9 per acre for work on outlet ditches, $20 for clearing, $3 for road work and bridges, and $3 for field ditches, the cost of placing the 4,300,000 acres of undeveloped land in organized districts in condition for cultivation would average $35 per acre above labor for clearing and without new farm structures and facilities.

The 24,600,000 acres of fertile cultivated land in organized drainage enterprises require the rehabilitation of outlet drainage systems but are cleared and largely provided with roads and bridges so that little or no expenditure would have to be made for such work. There is also a general lack of sufficient field drainage and the development of satisfactory systems would require an average expenditure of about $2 per acre. Estimating the cost of improving outlet drainage at $4 per acre, and the field drainage at $2 per acre, the cost of rehabilitating such land would average $6 per acre.

Wet land outside drainage enterprises.—In the humid sections of the United States there are approximately 98,000,000 acres of wet, swamp, and overflowed land still remaining outside of organized drainage enterprises. Of the 98,000,000 acres, about 20,000,000 acres are capable of development or improvement at moderate cost.

Based on the soil fertility and the drainage problems involved, it is estimated that about 6,400,000 acres of the wet but partially developed land can be drained and put into cultivation at a cost for outlet drainage ranging from $10 to $30 per acre and a cost for field drainage averaging $2 per acre. It is also estimated that about 13,648,000 acres of undeveloped but fertile land could be provided with outlet drainage at a cost of from $15 to $40 per acre. A large part of the undeveloped land is in cut-over timber and would require clearing and the construction of roads and bridges in addition to the construction of field ditches or drains. Clearing is estimated at $20 per acre above the settlers' labor, roads and bridges at $3 per acre, and field drainage at $3 per acre. These costs added to the cost of outlet drainage give a range of $41 to $66 per acre for draining and clearing the undeveloped fertile, wet, swamp, and overflowed lands. Farm structures and facilities would have to be added to obtain the cost of full development.

The land considered available for development or rehabilitation has been confined to areas of fertile soils of proven agricultural value. Much of it is located in the most thickly populated agricultural sections of the country and is adaptable to the general type of agriculture practiced in the region in which it lies. A considerable part of it can be brought under cultivation by the present owners without involving the problem of obtaining new settlers. In many cases the development of wet areas will enable farmers to abandon eroded hill lands and submarginal lands or place them in timber or pasture, and move their cultivated crops to the fertile bottom lands. Thus good land-use practices can be established in many instances without moving farmers to new locations.

Where resettlement is required, the development of the wet lands would make it possible to move those involved but a short distance where they could continue

types of farming with which they are already acquainted.

The following summary may provide perspective concerning possibilities in a drainage program:

	Acres	
Total area of wet lands (including land in organized drainage districts now drained)		177, 764, 000
Total area in drainage enterprises		79, 432, 000
Area that could be improved at moderate cost		28, 928, 000
Cultivated area	24, 628, 000	
Undeveloped area	4, 300, 000	
Total area outside drainage enterprises		98, 332, 000
Area that could be improved at moderate cost		20, 088, 000
Partially developed	6, 440, 000	
Undeveloped	13, 648, 000	
Area requiring higher costs or not susceptible to drainage		78, 244, 000

In brief, this suggests the possibility of developing or improving about 29,000,000 acres in drainage enterprises and about 20,000,000 acres outside drainage enterprises. Otherwise stated, it suggests the possibility of developing about 18,000,000 acres of new land in and outside of drainage enterprises and improving about 31,000,000 acres in and outside present drainage enterprises. The 18,000,000 acres of new land would provide 80-acre farms for 225,000 farm families and farm products for about 7,000,000 people. The improvement of 31,000,000 acres would increase the stability and standard of living for several hundred thousand farm families and also add to the Nation's production capacity and support for population. It should also be recognized that a drainage program such as indicated above would provide a large amount of employment in its development and could be easily adapted to purposes of employment stabilization.

The acreage physically possible of development through drainage is, of course, considerably greater than that suggested for development at moderate cost. There are over 78,000,000 additional acres of wet lands outside of drainage enterprises, a considerable proportion of which could be drained at higher cost. Should it be considered in the public interest to provide a high degree of public aid, the acreage that could be developed through drainage would be greater.

Land Development Through Clearing

Setting and Objectives

In the early history of the United States the rapid and destructive clearing of land for agriculture was common. "By 1880, about 150,000 acres, or 22 percent of the original eastern forest, had been removed merely to get at the soil and most of the trees were destroyed and burned as an obstruction to agriculture." [2]

[2] R. T. Ely and George S. Wehrwein, *Land Economics*, page 168. (1940.)

In those days clearing involved the removal of virgin timber. In the present day clearing tends to involve largely the removal of brush and stumps or small growth timber. A fast-moving lumbering industry has lumbered off vast areas of land. Although there was considerable emphasis on the development of agricultural land in the early years of this century, the rate at which forest lands have been cut over for timber has far outdistanced the ratio at which such lands have been developed for agriculture.

Cut-over lands have come to be something of a "no-man's land." The cut-over lands that have not been settled tend to be of low fertility, unfavorably situated, or subject to especially high clearing costs. Some of the lands which could be cleared for agriculture might yield a better income over a long period of years if returned to forestry. Perhaps one of the great handicaps to a successful utilization of much of the cut-over land of the country is the high valuation that has been placed upon it, on the assumption that it is suitable for agriculture. Farm abandonment and tax delinquency are notorious companions of settlement in cut-over areas.

A major reason for the widespread failure of settlement of cut-over areas has been the lack of careful classification of the land to determine its best use. There are undoubtedly cut-over areas both on farms and not on farms that are suitable for agriculture, but the total of such areas is probably a small proportion of all cut-over lands. A classification of such lands to determine whether they should be utilized for agriculture, returned to commercial timber, or directed toward some other use, is a prime necessity in developing a policy for the settlement of cut-over lands.

The fact that much of the cut-over land already settled is of poor quality places the development and settlement of new farms peculiarly close to the problem of resettling families now on submarginal land. The general problem of correlating new land development with submarginal land retirement is well illustrated within the cut-over land areas.

If the cut-over lands could be carefully classified, it is not unlikely that a large number of people now on submarginal farms could be given better opportunities by clearing more good land on those farms, or by clearing the better land for farms in new areas.

Land development and settlement through clearing, like its development and settlement through drainage or irrigation, has its setting in the growing national need for agricultural products and employment opportunities. The areas of cut-over lands that show a possibility of providing agricultural products at reasonable cost and of providing at least a minimum standard of living for farm people should, therefore, be carefully explored. Development possibilities in

this field should be compared with those in such other fields as drainage and irrigation.

A successful policy for cut-over lands must include not only careful classification and study of economic possibilities, but must provide guidance and assistance to settlers. The information can serve its most useful purpose only if it is in their hands.

Program Possibilities

It has been estimated that there are 170 million acres of forest and cut-over land not in farms which, without drainage, are physically capable of producing crops and that there are about 50 million acres of woodland in farms which are topographically suitable for farming, without drainage.[3] What proportion of this land considered physically capable of agricultural use can be economically developed for such purposes it is difficult to say. The large majority of this land is of very low fertility, sandy, stony, or rough. Probably only a small proportion of the forest and cut-over land physically capable of development can repay the costs of clearing and settlement. As a result of a nation-wide appraisal to provide an estimate of land suitable for cultivation, it was estimated that there were approximately 42 million acres of land in brush and timber suitable for cultivation under good soil conservation practices.[4] This estimate was made on the assumption of prices equal to the average for the period 1921 to 1936.

If 42 million acres of land could be economically developed through clearing and average yields could be assumed, food products would be provided for something like 15 million people and employment opportunities for several hundred thousand farm families.

The costs of clearing land vary considerably by areas and related conditions and also by methods used. On lands that have been cut-over for some time and on which the large stumps have decayed the costs of clearing tend to be relatively low. Gradual clearing by application of the settlers' own labor is particularly adapted to increasing the acreage for agriculture on land already in farms, and involves a relatively small cash outlay.

The prevention of settlement on cut-over lands submarginal for agriculture bears special emphasis. Rural zoning to prevent unwise settlement is, in a sense, a means of increasing the probability that such cut-over lands as are settled will result in a net benefit to the nation in terms of products and employment opportunities.

In recognizing the fact that the development and settlement of the better cut-over lands for agriculture may contribute to a growing need for agricultural products, we must not forget that the prospective need for timber products is also great. The lands most suitable for agriculture are often also best suited for commercial timber production.

In general, the cut-over areas are transition zones in which the appropriate types of land use are yet to be determined. To a large extent the agricultural use of land must be developed in relation to forest use and recreational use; and must be supplemented by income from related pursuits and industries. The rate of development of cut-over land for agriculture will, therefore, depend to a considerable degree upon the balanced development of cut-over areas.

There is no general public program for land clearing such as that for irrigation and water utilization, although the Farm Security Administration, the Work Projects Administration, and others have provided various types of aid to settlers on cut-over lands. There have been clearing activities in such areas as the Lakes States, the Pacific Northwest, and in the Mississippi Delta, but those have been private efforts or incidental to more general programs of public agencies.

The rapid clearing of lands by large-scale methods involves a greater original outlay per acre. It not only involves payment for the labor which a settler might otherwise perform, but tends to involve removal of green stumps. Whether the increased outlay is offset by the greater speed in establishing a farm as a going concern is uncertain.

The 1934 National Resources Planning Board report indicated a range by States in the estimated cost of clearing land under average conditions of from $10 to $50 per acre, except for the Pacific Coast States for which the estimate was $200 per acre. Recent studies by the Bureau of Agricultural Economics in cooperation with the experiment stations suggest that much land can be rapidly cleared in these States for about $50 per acre. It appears that new methods, such as the use of the bulldozer have, in recent years, reduced the cost and original outlay necessary for rapid clearing.

These costs do not include such costs as buildings and other improvements, interest, taxes, and community costs, etc., which must be included in the over-all cost of establishing a farm by clearing cut-over land.

Both the volume and the rate at which forest and cut-over land will be cleared and settled will depend on public policy as well as on costs and the need for new land. If any substantial portion of 42,000,000 cut-over acres were developed for agriculture, it would represent a large program of resource development and rural works. A liberal public-aid policy will tend to speed up development and settlement of cut-over lands.

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[3] *Report of the National Resources Board, 1934*, p. 128.

[4] See table 4, p. 95, of article by Utz, Kellogg, and others in the 1938 Yearbook of Agriculture.

Evaluation of Land Development and Settlement Activities

General Relationships and Plans

In approaching the evaluation of specific works or projects for land development and settlement it is important to bear in mind the relationship of land development and settlement generally to the broad objectives of providing increased productive capacity and population support. It is necessary to take into consideration also a wide variety of general plans and programs. It is, for example, necessary to note the relationship of land development generally to soil conservation; the relationship of land development on existing farms to its development in new areas; the relationship to each other of various phases of development, such as drainage, clearing, and irrigation; the relationship of land development to complementary or competitive activities, such as power, flood control, and navigation; and the relationship to general area plans.

It is to be noted that the development of land on existing farms and in existing enterprises differs somewhat from new land development. An important difference is that in the first case settlement and migration are not significantly involved whereas in the second they are. The desirability of a farmer clearing, draining, or irrigating additional acres on the farm where he lives raises issues quite different from those involved in the desirability of developing new farms by clearing, draining, or irrigating new areas. When a farmer is already in place, the clearing of new land is often a good way to utilize labor and expand his cultivated acreage to an efficient size. An entirely new set of buildings is not needed and the part of the farm already in cultivation may furnish or help furnish the capital necessary. In the case of clearing, furthermore, the stumps can be taken out as they decay and the high cost of rapid removal of green stumps avoided. Improvement of existing irrigation enterprises and the development of small water facilities on existing farms do not involve extensive problems of settling new families. It is more largely a matter of rehabilitation, reorganization of farm units, and placing an improved capital base under families that might otherwise be forced to go on relief or to give up entirely.

The development of new land areas, on the other hand, normally involves fairly large-scale operations and extensive problems of settler selection, guidance, and financing. It is coming to be the type of undertaking which requires public land acquisition, public construction, and public management in its early stages rather than merely aid to individuals.

The improvement of existing farms as well as the development of new farms tend to increase the nation's productive capacity and population support. Which new land should be brought into cultivation should not be determined by whether it is or is not now in farms, but by its productivity relative to the cost of its improvement. It is important to bring good land into cultivation both to increase the living standard of families in place and to provide new farm family units.

It is highly important that the development of additional land for agriculture, whether in farms or not, be preceded by careful study of the basic soil and water resources. The availability and stability of water supplies is especially important for irrigation. The nature of the soils is extremely important for all types of development. It should be certain that the lands to be developed are of such character and natural productivity that, with a moderate outlay for improvement, they will provide a satisfactory living for farm people. Adequate land classification should precede development and settlement.

The proposals and projects for land development must, of course, be judged in light of the regional situation in which they occur. Irrigation, for instance, must be judged in the light of the particular situations of the West with all its recent problems and need for stabilization. The drainage of wet lands must be carefully related to the special situations in the South and in other humid areas.

Land development proposals and projects are normally related closely to other developments, such as flood control, power development, and navigation; and these, as well as special regional situations, will bear on the choice between alternative proposals for land development.

Comparison of Costs and Benefits

There is a very large acreage of land not now in crops or intensively used, that is physically capable of development for these purposes. As previously stated, it has been estimated that water is available to supply 22,000,000 acres of new land through irrigation and to provide supplemental water to 11,700,000 acres more. It has been estimated that there are some 170,000,000 acres of forest and cut-over land not in farms and some 40 or 50 millions acres in farms that would be physically capable of producing crops without drainage.[5] There are over 96,000,000 acres of wet land not now in cultivation, a large portion of which is physically capable of producing crops after drainage and clearing, and an estimated 31,000,000 acres now in use whose productivity could be increased by drainage improvements. It appears, therefore, that there are well over 300,000,000 acres of land physically capable of use for crops if de-

[5] *Report of The National Resources Board*, 1934, p. 128.

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veloped through drainage, clearing, or irrigation. There are also nearly 43,000,000 acres now in use whose productivity could be increased by irrigation and drainage. It is, of course, obvious that the new acreage that would even come close to being capable of supporting farm families under the conditions likely to prevail in the foreseeable future is but a small proportion of 300,000,000. The benefits per unit of financial outlay will be instrumental in determining the proportion of the total acreage physically capable of more intensive use that should actually be developed for such use. A comparison of the ratio of costs to benefits should also be instrumental in determining the areas, the types of projects, and the specific projects within types that should have precedence in a general program for land development.

In considering the costs and benefits for specific proposals and projects for new land development, it should be recognized first of all that there is need for additional land of a productivity relative to cost greater than land now being retired from cultivation. It must also be recognized, however, that there are alternative possibilities for meeting the country's increasing needs for land and land products. The possibilities through irrigation, drainage, and clearing should, therefore, be carefully compared as should the individual projects in each of these fields. Only when this is done can there be a reasonable judgment concerning those projects which will give the greatest over-all benefits to society relative to total costs to society.

In attempting to arrive at an evaluation judgment concerning specific land-development projects, it may be helpful to consider the number of families likely to be supported at a reasonable level of income at a given over-all cost. If more families can be maintained at a reasonable income level, with a given over-all cost, on the new land than on lands of low productivity now in cultivation, the land development proposed is probably justified.

In arriving at a judgment concerning costs and benefits a wide variety of costs and benefits must be counted. It must be noted that the costs and benefits of a development project are not normally confined to the particular land area upon which these activities take place. Irrigation projects, for instance, often have their justification to a large extent in the stabilization they provide for surrounding areas. On the other hand, increased production of certain crops in a newly developed area may result in considerable hardship to other areas. In considering the cost of bringing a particular piece of land to a point where it will support a family, it is necessary also to count other costs than merely those for original clearing, drainage, or irrigation, such as interest, the costs of housing and home improvements, and the community costs which must be shared.

There are many costs and benefits of land development that cannot be given precise quantitative expression. It is believed, however, that a comparatively large proportion of the costs and benefits of such projects can be reduced to quantitative terms. The probable increase in future income, appropriately discounted to the present, can serve as a tangible item to compare with the calculable financial outlay. This should serve as a primary guide in comparing individual projects of a similar type with one another. It still leaves for the realm of general judgment and perhaps philosophy the proportion of intangible benefits that may appropriately be allowed for projects of a general type.

Financial and Institutional Arrangements

The extent to which Federal or other public aid should be given for land development is subject to debate. There should, however, be reasonable uniformity in the degree of aid given by the Government. The Reclamation Act provides for foregoing interest, and permits repayment over a 40-year period. The Wheeler-Case legislation permits additional aid in the way of WPA labor. There are no large, regular programs for Federal aid to land development through drainage and clearing, hence no general standards for sharing the cost have been established in these fields.

The arrangements for sharing the costs should be equitable not only as between landowners and the government but as between landowners and related beneficiaries. The advantage of land development to nearby areas and cities is difficult to measure; but these areas and cities should not be entirely free from sharing the costs. An arrangement by which nearby areas share the cost through their local governments should be looked upon with favor.

Many land-development activities are joint undertakings with multiple purposes. Irrigation and power, for instance, are often related. Satisfactory arrangements for allocating costs among the different-use beneficiaries should be indicated.

The nature of the financial arrangements, as against the proportion of the cost that is to be borne by the Government must, of course, vary somewhat with the type of development. For community projects it may be highly desirable for the Government to acquire the land and carry the whole project through the early stages of development before turning it over to private individuals. Public ownership or provision for acquisition well in advance of construction can serve to avoid speculation as well as settler distress. For small projects on individual farms favorable credit and technical assistance plus some recognition of ability to repay are of special concern.

Flexible arrangements for repayment in accordance with fluctuations in income should be considered as a desirable characteristic in all fields.

Institutional arrangements assuring the maintenance of improvements once installed, and conservational use of land upon which improvements are made, should be generally required.

Timing

The timing of land development activities may be viewed from the standpoint of the long-range outlook with respect to: (1) the need for agricultural products and (2) the need for employment opportunities and with respect to the short-run employment stabilization needs. The long-range problem is concerned with the needs for products and employment *resulting* from capital improvement and land development. The short-run problem is concerned with the employment provided *in the process* of capital improvement and land development. There is undoubtedly merit in a certain amount of slowing down of land development programs as a whole in boom periods and stepping them up in periods of unemployment. War periods, of course, present a special case. War needs for material and labor are an additional reason for the reduction of many land development activities but certain works already begun may be capable of completion soon enough to aid in wartime production. To accomplish such variation in total programs, it is necessary to determine which types of projects will have special merit during periods of unemployment and which types have special merit in boom periods and during the war. There will, of course, be many technical and engineering limitations to both the general speeding up and slowing down of land development programs.

Periods of high employment may well be utilized to make adequate surveys, studies and plans in order to have land development programs and projects well considered and the best ones ready for action at the proper time. "Readiness" in this sense will itself be an important condition for selecting projects in any period of unemployment that may occur in the future.

4. RURAL ELECTRIFICATION

Background and Setting

An outstanding characteristic of rural electrification in the United States prior to 1935 was the relatively slow progress in making electric service available to rural communities under conditions and at rates that farm people could afford to pay. Of the 6.3 million farms in the country in 1925, only 204,780, or 3.2 percent, were receiving central-station service. During the succeeding 6 years the percentage increased slowly, reaching 10.2 by January 1931. Then rural electrification almost came to a stop. From 1931 to 1935 the percentage increased only seven-tenths of one percent, to 10.9 in January 1935. Numerically, the increase was from 204,780 in January 1925 to 649,919 in 1931, and to 743,954 in January 1935.

Certain other countries have been well ahead of the United States in rural electrification. In 1935 about 10 percent of our farms were receiving central-station electrical service as compared with 95 percent in France, 90 percent in Japan and Germany, 85 percent in Denmark, 60 percent in New Zealand, and almost 100 percent in Holland. While it is recognized that conditions differ among these countries in such factors as density of population, type of farming, and per capita income, it is significant that they have developed methods to make electricity available to such a large percentage of their farms. In most of these countries, rural electrification has been characterized by wide availability, a high percentage of public or cooperative ownership, programs under Government sponsorship, and in some cases direct Government subsidy. It is unlikely that rural electrification would be so extensive in these countries except under such auspices, although it must be recognized that in most European countries, and in Japan, the density of population is rather high and the farming population usually lives in villages rather than on widely separated individual farmsteads.

Efforts to Extend Rural Services

Inasmuch as the private utility companies own and control about 90 percent of the electric-power industry in the United States, the extension of lines into rural areas prior to 1935 depended almost entirely on the willingness of these companies to serve farmers and other rural residents. During the years prior to 1935, the private industry made two efforts to extend rural service: the first, on an unorganized basis, extending from about 1915 to 1923; the second, on an organized basis extending from 1923 to 1935.

The first effort.—The power companies' first approach to the problem was that of selling and publicity, of extending urban lines into rural areas. Little effort was made to develop rural lines to meet the special needs and circumstances of rural areas. The farmers, except those living near towns and cities or along lines connecting towns, were usually required to pay the cost of line construction, ranging from $1,500 to $3,000 a mile, and turn the title to the lines over to the companies. In addition, the farmers were required to make substantial minimum monthly payments for service. In some cases the companies financed the line extensions, but set minimum monthly rates at a level which would amortize this investment within 5 or 6 years. Rates charged farmers for power, based on complicated rate schedules, ranged from 8 cents to 25 cents per kilowatt-hour. Under these conditions and rates the financial burden was too great for the vast majority of farmers. As a consequence, few were able either to obtain service or to utilize it fully. The companies did not want to invest large blocks of capital in rural territory when they were experiencing a satisfying increase in business from the more profitable and easily accessible markets in urban areas of denser population. From a strictly business point of view this was a normal attitude. From the viewpoint of the farmers, however, the results were not satisfactory and they became more insistent that something be done.

A second attempt.—In contrast to the first attempt in which the private companies took the initiative, the second endeavor developed from farm pressure. "The demand for rural electric service has produced an acute and embarrassing situation for the electrical industry due to the new and undeveloped state of electric energy on the farm," reported the chairman of the Rural Lines Committee of the National Electric Light Association in 1923. The industry generally, however, was not convinced that the farm market would develop a paying load. But it agreed to look into the question by entering, in September 1923, into a broad cooperative effort—the Committee on the Relation of Electricity to Agriculture—which came to be called the "CREA."

CREA a fact-finding and educational approach.—The CREA was composed of outstanding leaders of the utility industry and representatives of leading farm organizations, professional societies, manufacturers' associations, and the Federal Departments of Agriculture, Commerce, and Interior. State committees were established in 27 States composed of leaders with connections similar to those of the national committee. The

undertaking was generously underwritten by the industry and received support from the American Farm Bureau Federation. Its primary functions were those of fact finding and education. Engineering research was conducted at the agricultural experiment stations by experts, both laboratory and field tests were made for applying electric power to all sorts of farm machinery and appliances, new uses were developed, and a large number of valuable publications and technical reports were issued on the applicability of electric power to agriculture.

The CREA effort made a valuable contribution to rural electrification through its stimulus to research and educational undertakings. The technical findings and publications provided a substantial background for subsequent activities. But it failed to accomplish the purpose sought by the farmers—widespread extension of electric power at rates they could afford to pay.

One important group of problems relating to rates, conditions of service, and line costs was not subjected to study by the CREA. During the CREA period line costs still remained at a high level, ranging from $1,500 to $2,500 a mile, and the national average of rates was 9 to 10 cents per kilowatt-hour.

After about 10 years of intensive work the national farm organizations withdrew from membership in the CREA in 1934. The following year the Departments of Agriculture, Interior, and Commerce also withdrew. The Committee finally disbanded in 1939. The withdrawal of the farm organizations and Federal departments from the CREA was significant. It foreshadowed a new type approach to the problem of securing rural electrification.

The Federal Rural Electrification Program

Emergency status.—The emergency program of the Federal Government in 1935 to relieve the serious unemployment situation and to stimulate industry, established the basis for the promotion of rural electrification under Government auspices. In recognition of the economic and social benefits of wide availability of electric power in rural communities, the Congress gave specific approval to rural electrification as among the desirable projects in the Emergency Relief Appropriation Act of 1935. Under that act, by an Executive order of May 11, the President established the Rural Electrification Administration as an emergency agency "To initiate, formulate, administer, and supervise a program of approved projects with respect to the generation, transmission, and distribution of electric energy in rural areas." Relief funds were made available to be loaned to private companies, power districts, municipalities, and cooperatives.

Permanent status.—The emergency program was well received by rural and urban people alike. It was soon realized, however, that in order to make electric power widely available to farm people, a long-term program was necessary. Farm organizations strongly supported this viewpoint. The Congress passed the Rural Electrification Act of 1936 which reestablished the Rural Electrification Administration as a more permanent agency of the Federal Government and authorized a long-term lending program.

Briefly, the Rural Electrification Act of 1936 provides that loans, which shall be self-liquidating within a period not to exceed 25 years, may be made to persons, corporations, States, Territories, municipalities, peoples' utility districts, and cooperative, nonprofit, or limited-dividend associations organized under the laws of any State or Territory of the United States, for the purpose of financing the construction and operation of generating plants, transmission lines, and distribution lines for the furnishing of electric energy to persons in rural areas who are not receiving central-station service. These loans are made on terms and conditions determined by the Rural Electrification Administrator and may be made payable in whole or in part out of income. The loans to cooperatives, which are generally 100 percent of the cost of building the distribution systems plus some working capital, are secured by mortgages on the systems. The original equity of the cooperatives, which later increases steadily as repayments of principal are made, consists only of the $5 membership fees of the members. The Act also provides that loans may be made for wiring premises and the acquisition and installation of electrical and plumbing appliances and equipment. Such loans may be made to borrowers of funds loaned for line construction or to businesses supplying and installing wiring, appliances, or equipment. All loans bear interest, the rate for any year being the average rate of interest paid by the Federal Government on its obligations maturing in not less than 10 years and issued in the preceding year. The Act specifies that no loan shall be made unless the Administrator finds and certifies that in his judgment the security therefor is reasonably adequate and that the loan will be repaid within the time agreed. In accordance with the terms of the Act, the interest rate on Rural Electrification Administration loans made in each fiscal year has been as follows: 3 percent in 1936, 2.77 percent in 1937, 2.88 percent in 1938, 2.73 in 1939, 2.69 in 1940, and 2.46 in 1941. The Act made provision for a 10-year loan program: $50,000,000 to be borrowed from the Reconstruction Finance Corporation in the fiscal year 1937 and $40,000,000 authorized for each of the succeeding 9 years.

Although the Rural Electrification Administration is an action agency, it should be noted that the agency is not authorized by the Rural Electrification Act of 1936 to establish a national program of rural electrifi-

cation in the sense that it may predetermine specific areas to be electrified in any year and the order of their electrification. The wording of the Act and various statements in committee reports and debates and at committee hearings indicate that the Congress contemplated the eventual electrification of all rural areas of the United States where it is economically feasible; and that the Rural Electrification Administration shall proceed generally on the basis of inquiries and requests from eligible borrowers that arise spontaneously from such borrowers in whatever part of the United States they may exist. The Act specifies that one-half of an appropriated annual loan fund shall be distributed among the States in accordance with the ratios of the number of their respective farms not receiving central-station service to the total of farms in the United States not receiving such service; and that the other half of an annual loan fund may be distributed among the States at the discretion of the Administrator, but not more than $10,000,000 in any one State.

While the Rural Electrification Program is encouraging and aiding the electrification of rural areas by the lending of Federal funds, it is more than a lending program in the strictly banking sense. For instance, the Act provided for loans to finance not only the construction of electric facilities but also the acquisition of electrical equipment and appliances in order that rural people could obtain optimum benefits from the service. The Act assumes that electricity is an essential technological resource and a necessity in modern life, and that in the interest of the public welfare it should be plentiful, cheap, and widely distributed. In order to take electricity to the farmers of the country the many barriers that had impeded progress in the past had to be removed or substantially modified. This meant a new approach on many fronts; comprehensive area development, lower construction costs, more favorable rates and rate schedules.

When the program was inaugurated in 1935, it was assumed that the greater part of the funds would be lent to existing private companies because they were going concerns, and that a minor part would be lent to cooperative and other nonprofit associations. The development of the program, however, has been radically different from this initial assumption. Instead of private companies constituting the major group of borrowers, approximately 98 percent of the loans have been made to cooperative and other nonprofit borrowing organizations, most of which have been set up by the farmers in communities under their respective State laws for the specific purpose of borrowing these funds. This was in harmony with the provisions of the Rural Electrification Act which accorded preference to the nonprofit type of enterprise in allocating loan funds. The objectives of the Congress to make electric power available to as many farmers as possible at lowest rates through self-liquidating loans and the emergence of the cooperative as the principal type of borrower have involved a large number of pioneering undertakings.

Area service to broaden coverage and reduce costs.—One of the basic principles that has been followed in the rural electrification program is that of area service. This principle is of fundamental importance for at least two major reasons: comprehensive coverage and resultant lower construction costs. One of the common practices of the past—still engaged in by some private companies—is that of extending lines only to those farms promising relatively large immediate loads and of ignoring all other potential customers. In most instances this practice, often referred to as "skimming the cream," deprives the large number of remaining farms of the possibility of ever receiving electric service because the cost of extending lines to them as a distinct group in the future becomes exorbitant. On the other hand, the principle of area coverage assures service to substantially all farms within an area because mass-production methods can be employed and costs can be averaged over both large and small consumers. The application of this principle of area service has eliminated one of the greatest barriers to widespread farm electrification.

The principle of area coverage has been accompanied by revisions in terms of service and in rate schedules. By placing line construction on a mass-production basis and by simplifying and standardizing designs and materials, the cost of rural lines has been reduced substantially. At the beginning of 1935, although costs had declined from earlier levels, the reported cost of rural lines, depending chiefly on the terrain, ranged from $1,500 to $1,800 a mile. The cost of lines financed by the Rural Electrification Administration now averages less than $1,000 a mile. Through large-scale production made possible by comprehensive area coverage, and development of long span construction with high strength conductors and new equipment, substantial contributions have been made to broadening the area of economical, widespread rural electrification. Transformers, meters, and other items of equipment have also been studied and redesigned to obtain maximum performance at lowest possible costs. Partially as a result, there has also been a substantial reduction in rates paid by farms for electricity since 1935.

Cost of electric power reduced through guiding cooperatives.—The cooperatives are newly formed, nonprofit associations of farmers who generally have had little experience in the organization and conduct of large-scale industrial business enterprises, and who have had little experience with the technology and business of electric utilities. As a consequence, it is essential that these cooperatives be given expert aid in order

that they may constitute sound borrowing organizations, that they may be established properly in accordance with all applicable laws, and that their electric systems be designed and constructed to conform to all engineering and legal requirements. This results in a sound base for low cost and efficient service to the farmers. After the lines are built and energized, the Rural Electrification Administration maintains a close working relationship with these borrowers to guide them in establishing an efficient management, including adequate maintenance and economical operation. Since the interest and principal payments to the Government must come from the revenues received by the borrowers from their sales of power to their members, advice to cooperatives tends to protect the Government's loans. The activities of the Rural Electrification Administration are of an advisory nature and do not involve participation in the actual operation of the projects.

Influence of rural electrification program on private companies.—The rural electrification program, in addition to providing funds for financing rural electrification, has exerted a strong influence on private utility companies by stimulating and arousing a renewed interest on their part in the possibilities of electrifying rural areas. The general adoption of the REA low-cost construction techniques by private companies has been an important factor in influencing extension of their lines into unserved rural territory. However, in some areas, the threat of competition of REA financed rural lines has provided the major stimulus to the increased rural electrification activities of the private companies.

Many private companies have modified their terms greatly and have offered lower and more promotional rate schedules. In addition to reducing line costs, many of them have eliminated the requirement that farmers must pay for the cost of the line at time of construction and are now building lines without requiring immediate investment or obligations by the farmers. High monthly minimums have been substantially reduced in many areas. Even the principle of area service is becoming practice for some of the more progressive companies, but in many areas selective or "cream-skimming" practices are still prevalent, a factor that may seriously handicap the electrification of many farms in the future.

Summary.—In the development of rural electrification in the United States there have been three efforts to make the benefits of electricity available to rural communities: a somewhat spontaneous effort on the part of the electrical industry in 1910; the effort beginning in 1923, stimulated by the farmers and carried on with the cooperation of the industry and certain government agencies under the leadership of the CREA; and the effort beginning in 1935, also stimulated by the farmers, made a part of its program for agricultural and economic recovery by the Federal Government, and carried forward under the leadership of the Rural Electrification Administration. The first effort was apparently fruitless. The second effort based primarily on fact finding and education, emphasized the potential value of electricity on the farm but failed to solve the problem of how to get it there at a price the farmer could afford to pay and consequently bogged down to the point of abandonment as a definite program. The third effort based on the premise that rural electrification is largely a problem of the cost of service has produced substantial results and encouraged the belief that the American problem of rural electrification is well on the way to an effective solution.

The increase of rural electrification in the United States since 1935 has been striking as compared to the earlier rate of growth. During the 6-year period January 1935 to June 30, 1941, the number of farms with central-station service has increased from 744,000 to an estimated 2,126,150, or twice as many electrified in the past 6½ years as in all previous years. By August 31, 1941, REA allotments totaling over $388 million had been made to 845 borrowers. Of this total, more than $365 million was for the purpose of constructing 372,551 miles of line to serve eventually 1,215,447 farms and other rural consumers. Of the 845 borrowers, 771 were cooperatives, 50 public bodies, and 24 private companies. By the end of August 1941, there were 749 borrowers' systems in operation with 323,757 miles of line energized and 826,046 consumers connected.

From an operating standpoint, these newly established systems are showing substantial progress. A comparison of the systems on the basis of age group reveals: monthly revenues per mile are increasing from $6.38 for borrowers 1–6 months old to $7.89 for borrowers 19–30 months old to $10.71 for borrowers 43 months and older; consumers per mile are increasing from 1.65 for 1–6 months group to 2.33 for the 19–30 and to 2.79 for the oldest group; kilowatt-hours per consumer are increasing from 39 for the 1–6 months group to 46.9 for the 19–30 and to 60.0 for the oldest group.

Experience with repayments to date has also been encouraging. On distribution, transmission, and generating loans, total interest and principal due by September 30, 1941, amounted to some $10,729,000. All of this had been paid except for some $98,000 overdue, or less than 1 percent. Sixteen borrowers were overdue on interest payments and 11 borrowers on principal payments. On the other side, advance payments by 300 borrowers totaled just over $3,500,000 and the principal of notes paid in full amounted to some $310,000.

In interpreting these figures two things should be borne in mind. Maintenance, operating expenses, taxes, and insurance are, of course, a first charge on the revenues of each system, to be met before repayments of interest and principal. Secondly, the repayment schedule is set up to reflect the operating experience of new systems, a gradual increase of revenues over the first few years. Interest is accumulated for the first period; current interest is payable during the second period; and increasing amounts of principal are payable during the remaining periods.

A Potential Program

Satisfactory estimates of the possible magnitude of a rural electrification program are not now available. Fairly reliable estimates may result, however, from surveys now being made in connection with the postwar planning activities of the Department of Agriculture and the preparation of development plans under Executive Order 8455. Until these surveys have been completed, all that can be done is to indicate in a very general way the size of the job that is ahead.

The most recent Rural Electrification Administration survey showed that there were 2,126,150 farms with central-station electric service on June 30, 1941. The census reported a total of 6,096,799 farms as of April 1, 1940. These figures would indicate an outside limit of future rural electrification of 3,970,649 farms. To this must be added the large number of nonfarm potential users of electricity—rural schools, churches, Government enterprises, nonfarm rural residents, and commercial and industrial establishments. Experience indicates that 15 to 20 percent of the consumers on REA-financed lines are included in this category. Using a figure of 15 percent, the total potential number of rural consumers not served on June 30, 1941, is raised to 4,500,000 in round figures.

Just how many of these 4,500,000 potential rural consumers it may be possible to serve depends upon a host of unpredictable factors. Further technological advances and improved techniques will undoubtedly reduce further the cost of line construction, of power production, and of electrical apparatus and thus extend the potential market for electric service, but no one can predict how much. Lower and promotional rates and an expanding use of electric power on the farm will tend in the same direction. It should be noted, however, that the census reported some 900,000 nonelectrified farms within a quarter of a mile of existing high lines. Service to these farms would generally require merely a short connection, the cost of which would be very low in the vast majority of the cases and depends primarily on the desire of the individual farmers for electric service.

A more tangible factor is financing terms. Lengthening of the period of amortization beyond the present 25-year maximum would serve to extend the magnitude of the potential program of the Rural Electrification Administration without materially changing its self-liquidating nature. A reduction in interest rates would also tend to expand the program; but this change, although not technically a departure from the principle of self-liquidation, would substantially increase costs to the public. Funded debts of private utilities tend to be refunded continually, and a good case can be made for not requiring a single generation of farm and other rural people to pay the entire capital cost of an enduring asset such as rural electrification. So long as the present provisions for voluntary advance payments on loans are retained, a lengthening of the amortization period would not require the more prosperous cooperatives to pay interest charges for any longer than they now do. The cooperatives would be able to choose between lower annual costs during a long period of amortization or lower total costs over a short amortization period. Liberalization in the extension and rate policies of private companies would also have a substantial influence on the number of farms to be electrified.

Recognizing fully the danger of attempting to make any kind of forecast in a situation with so many unpredictable factors and in advance of adequate surveys, it is estimated conservatively that at least 50 percent of the unserved farms and other rural users can be supplied with electricity under the financing requirements of the present Rural Electrification Administration program, assuming present technological and economic conditions. This means that over 2 million additional farms and other rural users would be supplied with electricity. This is a total equal to about twice the number that will be furnished service by the systems which had been allotted funds by the Rural Electrification Administration on June 30, 1941, when their lines are fully developed. If the amortization period were lengthened, as noted above, it is probable that service could be extended to a number considerably in excess of 2,000,000. Estimates of the number of farms that can be served on a self-liquidating basis have been subject to continuous revision because of constant improvements in the field of rural electrification. Reductions in line costs, improved techniques, expanding uses of electric power on the farm and in rural areas, lower and promotional rates, the development of cooperatives—all of these dynamic factors have resulted in the discarding of earlier estimates of economical rural electrification. The introduction of varying degrees of subsidy would, of course, tend to expand the magnitude of the potential program.

It should be emphasized that the possibilities for rural electrification, at any given level of technology

or any assumed financing arrangements, are based upon adherence to the principle of "area coverage." Without this principle, not only would there be very little future possibility of further rural electrification on a self-liquidating basis, but practically all of the systems constructed since 1936 would not have come into existence.

Evaluation of Rural Electrification Programs

Costs and Benefits

So long as rural electrification programs are carried out on a self-liquidating basis, the measuring of benefits against costs is not a problem of major importance. Electric power is measurable and the distribution of costs among consumers is dependent on rates and quantities used. As in other self-liquidating public programs, and in private economic activities, it is assumed that the benefits to the consumer are worth at least what he pays for the service.

On the other hand some general showing of public benefits is presumably desirable even for self-liquidating programs. For one thing, there should be some reason for the Government entering the field rather than leaving it entirely to private individuals. Moreover, some risk of loss exists in even the most carefully considered program when 100 percent loans are made, and the public benefits should be great enough to cover such possible losses. Finally, the fiscal authorities may need to consider the effects of proposals for Government financing on the general financial operations of the Government.

For these reasons it is desirable to consider the intangible and general public benefits which may accompany rural electrification. These intangible benefits are of some significance in determining the proper size of annual advances in a self-liquidating program, and they would become of prime importance in determining the extent to which a public subsidy would be justified. A number of European countries have apparently given great weight to general and intangible benefits in formulating their programs to extend rural electrification very widely even when this required rather large Governmental financial contributions.

The most widespread of the intangible public benefits of rural electrification is its general contribution to the social and physical well-being of rural America. Electricity can promote the all-round improvement of rural life in many ways. Electric power releases the farmer and his family from necessary drudgery of many daily chores like the pumping and carrying of water. Some of the time thus freed is available for social and cultural activities. The effects of electric power on health are substantial because it makes possible modern plumbing, refrigeration, running water, the bathtub and the inside toilet—all of which are important contributions to sanitation. Adequate light removes an important obstacle to reading and study, and to many indoor social and community activities. Electric lights in home and school will help to save the eyes of many rural children.

Of more strictly economic importance is the contribution that rural electrification can make to real farm income by making possible increased production for home use and for the commercial market. The application of electric power to productive farm operations has just begun because up until recent years there was not a sufficient market to encourage manufacturers to design electrical equipment and appliances specifically for productive use in agriculture. Electrical equipment for dairy and poultry production is widely used and a good start has been made in developing many new items of equipment for farm use. For example, a one-can milk cooler has been designed to sell at a fraction of the price of two-can coolers which were formerly the smallest size available in the market. Equipment is also being designed which the farmer himself can make or assemble in his own workshop. The freezer locker plant is an excellent example of electrical equipment which encourages the production of home-grown foodstuffs and meats.

The possibilities of industrial decentralization which rural electrification holds out is also considered by many people as an economic and social benefit of great potential significance. Without entering into the merits of this position, it can be pointed out that the availability of electric power in rural areas certainly tends to remove an obstacle to the greater dispersion of industrial activity. How important this power factor may be in relation to other factors such as raw material and labor supplies, transportation costs, and the location of consuming markets can probably be determined only by the test of experience. Experience to date indicates that there has been a substantial increase in the number of industrial and commercial consumers of power on REA-financed systems. At the close of 1940 there were 5,365 such consumers requiring transformers of 5 kv.-a, or more, an increase of 53 percent over 1939. Their total connected transformer capacity increased 86 percent in the same period. Most of these consumers, of course, were already there—filling stations, elevators, quarries, and saw mills, which shifted to electricity from some other source of power, such as gasoline or Diesel engines. A few have come into being because of the availability of power. It should be remembered in this connection that the influence of rural electrification is at the outermost perimeter of industrial decentralization—for the most part in the open country. Electric power has been available to a vast majority of towns of 1,000 or over for some years.

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Still another general benefit, which rural electrification shares with many other programs, is its stimulus to employment and economic activity in periods of depression. It will be remembered that the REA program was inaugurated in 1935 with funds from an emergency relief appropriation before being placed on a different legislative and financial basis in the following year. In considering this aspect of rural electrification, it is important to consider that a very high proportion of the employment is off-site employment in the manufacture and transportation of materials. Only about 20 percent is direct employment in line-building. Thus a given amount spent on rural electrification will provide considerably more employment in industry than in the rural areas where the lines are built. The high consumption of metals and other materials, both in line building and in the manufacture of equipment and appliances, may be a particularly important factor in the post-war period as a contribution to the utilization of our greatly expanded facilities in the metal industries.

Distribution of the Costs

The question of the distribution of costs—like that of comparing costs and benefits—is not an important problem as long as rural electrification programs are maintained on a self-liquidating basis. The consumers are expected ultimately to pay all the costs, except for the less than 1 percent contributed by the Federal Government for the administrative expenses of the REA. If some form of a subsidized program of rural electrification were deemed desirable, the intangible benefits discussed above would serve as a guide in considering the amount of aid and the particular levels of Government which should furnish the assistance. On the basis of these general and intangible benefits, a judgment might be made as to whether and to what extent local, State, or Federal Governments should assume part of the costs.

Area and Regional Plans

There are two principal fields in which a rural electrification program ties in with regional and area planning—relationships to agricultural economy of an area and its soil and water resources and planning for the most effective and economical production and distribution of electric power. As has been mentioned, the Administrator of the present REA program is rather restricted in the scope of his discretion in both these fields of planning. The Rural Electrification Act of 1936 does not authorize the REA to establish a national program of rural electrification, which would proceed by laying out a master plan and set up priorities of need and economic feasibility by areas. Instead a specific 10-year program was laid out which required one-half of each year's loans to be distributed among the States according to the percentage of unelectrified farms and the other half to be allocated at the Administrator's discretion provided that not more than $10,000,000 be loaned in any one State. The standard established for the making of individual loans is that they shall be self-liquidating, in the judgment of the Administrator, over a period of not more than 25 years.

The requirement of self-liquidation is, of course, a standard which, when carefully applied, can to a large extent substitute for other types of planning. Before a loan application is submitted to REA, a community organization must survey the area and obtain consumer applications for service and plan its power system. The economy of any particular area must be on a fairly stable base to justify a 100-percent loan extending over a period of 25 years. If, for example, an area is likely to be largely retired from farming use either by voluntary abandonment or Federal purchase, or the ground-water supplies for pump irrigation will be exhausted within this period, the feasibility of a self-liquidating project would be small unless there was, of course, sufficient demand for electric service from nonfarm consumers, such as industries or resorts. The REA examines these aspects of each application and the other bureaus and agencies of the Department of Agriculture are drawn upon for advice and technical assistance.

Consideration of the possibilities of rural electrification within practicable transmission distances of proposed Government hydroelectric power and multiple-purpose developments is of great importance. The availability of power at low rates may make rural electrification an economic possibility in areas which it might otherwise not be possible to serve. Conversely, the market for power in rural systems may bring about a favorable cost-benefit ratio in multiple-purpose water projects. The REA has worked closely with the Federal Power Commission, the Corps of Engineers, the TVA, and the Bonneville Power Authority on these questions.

Timing

The line-building phase of a rural electrification program lends itself well to employment stabilization because of the physical nature of the job. An average project can be completed in about 9 months, which may make possible a considerable degree of flexibility in expanding and contracting the program. The administrative organization of the REA has also shown itself capable of handling a greatly increased volume of loans when necessary. The legislation set forth a basic 10-year program involving $40,000,000 in loans each year.

but when the Congress has increased the appropriation or loan authorization, the REA has been able to operate at a much higher level.

On the other hand, there is probably some undeterminable annual level beyond which it would not be possible to step up the loan program of REA, especially at very short notice. The development of a loan application by a local group may be a rather lengthy process—requiring up to 2 or 3 months—in order to sign up farmers and other potential consumers, secure wholesale power at a reasonable rate, have engineering studies made, and perform many other similar organizational jobs. Projects can now be developed more rapidly than in previous years, however, because there are now over 800 cooperatives in existence and they operate in over 2,300 counties in 45 States. As a consequence, these cooperatives can develop new projects for additions to their systems without the necessity of starting new organizations. The backlog of applications for loans is not large relative to the potential program that lies ahead. Applications for loans received by REA tend to reflect the amounts of loan funds authorized by Congress. Because of developmental costs leading up to a submission of an application, not to mention the large amount of time which is contributed to secure signed membership cards, local groups are not likely to undertake this expense and trouble unless it is reasonably certain that funds will be available for their projects.

There is some question as to the extent to which a self-liquidating program of rural electrification should be expanded and contracted with changes in general economic conditions. The farmers who want electric service may feel that as long as they are paying the costs of the systems, they should be able to secure the loans when they want them. This feeling must be tempered, of course, by the needs of the economy as a whole, but it may indicate that extreme variations in the magnitude of such a program from year to year are not desirable. When general public benefits are substantially equal, perhaps the greatest use of the "accordion principle" in public works activity should be reserved for programs in which the direct Government contribution is high.

5. RURAL HOUSING

Background and Setting

The farm home is generally an integral part of the farm enterprise. A program for rural housing must, therefore, be carefully integrated with the programs for agricultural conservation, development, and adjustment. The problem of farm housing as it bears on farm living is, however, worthy of special attention. The more serious housing deficiencies tend to be found among low-income farmers, tenants, and laborers.

Housing, even in urban areas, has only recently come within the scope of public interest and Government action in the United States. Cities have had building regulations for a long time, and some of the older eastern metropolises, such as New York, have been concerned for some decades with the problem of slums and tenements; but positive Government action in the interest of improving urban housing conditions has largely developed since the great depression. Like many other activities in widely separated fields, Federal action programs in the urban housing field were inaugurated largely as a means of combating unemployment and depression. The construction industry was perhaps the most seriously depressed of all major economic activities, and a public works program was launched to relieve unemployment in the construction trades and to stimulate the entire economy. One of the elements of the $3.3 billion public works appropriation of 1933 was the PWA slum-clearance and low-cost urban housing program. This program, again like many others, was later set up on a more permanent basis in the United States Housing Act of 1937 which provided for Federal financing and an annual Federal subsidy to local housing authorities to enable them to provide low-cost urban rental housing and for an equivalent amount of slum clearance. For the higher income groups, the FHA program of stimulating private housing by guaranteeing mortgages and thus lowering financing costs was likewise devised primarily as a recovery measure.

The field of rural housing was still less explored prior to the great depression than urban housing, and consequently it did not receive as great a stimulus from the Federal recovery programs of the 1930's. Moreover, the recovery program for American agriculture tended to be concentrated heavily on direct price and income-raising measures rather than on public works or employment-creating programs.

Nevertheless, the depression and the government recovery programs of the 1930's did bring about an intensified exploration of agricultural problems and the inauguration of programs which touched upon, even if somewhat indirectly, the farm housing problem. The Farm Housing Survey of 1934, a CWA project, provided the first comprehensive information on the condition of farm housing. The data in this survey were basic to any attempt to analyze the nature and the magnitude of the problem of farm housing. Likewise, the depression-born Resettlement Administration, later transformed into the Farm Security Administration, became the first action agency of the Federal Government concerned primarily with the low-income farm family and out of its experience there developed an appreciation of the rural housing problem and suggestions for dealing with it.

It should be pointed out, however, that the field of rural housing is still largely unmapped and that there is still no general farm or rural housing program. There are a number of programs, however, which provide assistance for new farm housing and for rehabilitation and repair.

The housing activities of the Farm Security Administration include: Construction and repair of houses, farm buildings, and sanitary facilities on tenant purchase farms; construction and operation of migratory labor camps and labor homes; housing on Wheeler-Case irrigation projects; and housing constructed by land purchase associations. The Tenant Purchase Program under the Bankhead-Jones Act of 1937 provides for 40-year loans at 3 percent interest to farm tenants for the purchase of farms. These loans may and do include funds for the rehabilitation and repair of existing houses on the farms purchased, and if necessary, for the construction of new houses. Of the 20,720 loans which had been approved by June 30, 1941, 10,279 or about one-half provided for repair of houses and 9,915 or over 47 percent for the construction of new farmhouses. For migrant agricultural laborers 42 permanent camps and 30 mobile camps were completed or under construction on December 31, 1941, largely on the West Coast but with some in Idaho, Arizona, Texas, and Florida. The shelters and tent platforms in these camps will provide for some 19,400 families at one time. In addition, there are some 2,200 individual small labor homes with attached garden plots located near the camps. Housing will be a significant part of the Department of Agriculture portion of the Wheeler-Case irrigation program, but this activity is just getting under way. Some housing, both new construction and repair, is involved in loans which are made under the rehabilitation program to cooperative associations of farmers for the

purchase and development of large tracts of land, frequently existing plantations. The FSA also administers some 164 homestead or resettlement projects started by the Resettlement Administration, the Subsistence Homesteads Division of the Department of the Interior, and other prior agencies. Considerable housing was provided on these homestead projects at one time, which has furnished valuable experience in designing and constructing low-cost farmhouses, but new projects are not being started and the existing projects are now rapidly being transferred to the ownership of the residents on them.

A small amount of housing is also involved in certain other Department of Agriculture programs. The Forest Service has provided some housing, housing repair, and sanitary facilities for low-income families on national forests lands, especially in the eastern and southern States. Land-bank and commissioner loans under the Farm Credit Administration have included a very small proportion of funds for new housing and for repair where the value of the land has been sufficient to meet the statutory requirements for security. The Rural Electrification Administration makes loans to cooperatives for the installation of wiring, electrical equipment, and plumbing for their members.

The USHA program, although designed primarily to provide urban low-cost housing, is also authorized by statute to operate in rural areas. Early in 1940, six rural projects in as many States in the South and Middle West were approved. These projects consisted of individual farm dwellings, each on an acre of land owned by the local housing authorities. As in the urban projects financed by the USHA, these houses were to be rented to farm families, since the statute does not now permit sales.

It is significant that, except for migratory labor camps and the USHA rural projects, housing is not the primary objective of any of these programs: it is incidental to a major objective such as farm ownership, rural rehabilitation, or the provision of farm credit. Part of the reason for this may be the lack of information on the farm housing situation until very recently, but more important is the fact that farm housing involves much more than the mere provision of a dwelling. Unlike urban housing, which is largely a problem of shelter, health, and social conditions, the farmhouse is also an integral part of the productive unit from which the farm family makes its living. Thus it is intimately related to all the problems of the farm business, including tenure, farm management, soil conservation, adequate acreage, and land use adjustment. This close relationship between housing and the business of farming has made it appropriate to approach the housing problem in large part through measures designed to provide an adequate and stable farm income. A primary objective of public policy has been to assist the farmer to obtain and maintain a farm from which the family can make an adequate living, which includes a decent house as well as many other things.

The Present Condition of Farm Housing.

The most important source of information on the condition of farm housing available at this time is the Farm Housing Survey, a CWA financed project which was carried out under the direction of the Bureau of Home Economics in 1934. The survey was designed to measure the potential demand for improved housing and related facilities on farms. By means of a house-to-house canvass, data were secured for 595,855 occupied farmhouses in 308 counties of 46 States, or 8.6 percent of the occupied farmhouses reported for the surveyed States in the Census of Agriculture for 1935. More recent data of the same general type will be available some time during 1942 from the 1940 census, but the census tabulations which have been completed for a few States indicate that conditions have not materially changed since 1934, except perhaps for plumbing which has been stimulated by the increase in rural electrification.

Three measures have been chosen from the data in the farm-housing survey, the census, and other sources as being most significant yardsticks of the existing level of farm housing: (1) the value of farm dwellings; (2) the size of farmhouses in relation to family size; and (3) the condition of houses and repairs needed. The condition of existing sanitary facilities, another important facility closely related to housing, is presented in a separate section.

Comparison of urban and rural housing.—Before considering this statistical material on farm housing, it may be helpful to examine briefly the problem of comparing the existing levels of rural and urban housing. Two important elements in most surveys of urban housing have very little relevance to rural housing: the number of vacant houses and the age of houses. A count of vacancies means very little because of the nature of the farm business. Few farmhouses are left vacant in locations where families can still make a living from the land, and vacant houses in other localities are of no value except for the possible salvage of materials. There is also no consistent relationship between the age and condition of farmhouses. Many of the older houses are better than the new. For example, the best levels of housing as revealed by the Farm Housing Survey were in New England and the Middle Atlantic States, where the average age of houses is considerably higher than in most other regions of the country.

A comparison of the value of rural and urban houses is likewise difficult. Census figures on the value of farmhouses do not include the cost of the land as in the case of urban houses. Building costs have probably averaged somewhat higher in the cities because of higher labor costs and the fact that farmers frequently contribute a good share of the labor and often some of the materials in building or repairing their houses.

In view of these and other factors, if comparisons are made between the levels of urban and rural housing, it is safer to base them on such things as the physical condition of the housing, the nature of the sanitary facilities, and the degree of crowding.

Value of Farm Dwellings.—According to the preliminary data from the 1940 census, the value of farm dwellings decreased from 1930 to 1940. The value of all farm buildings, including dwellings, decreased from $12,950,000,000 in 1930 to $10,405,000,000 in 1940, or 19.7 percent, during which time the combined value of land and buildings decreased 29.7 percent. The decline in the value of all farm property is undoubtedly in part a result of the general economic depression; the decline in the value of farm dwellings and other buildings, however, also reflect additional use without adequate repairs.

In 1930, the total value of all farm dwellings, without the value of other farm buildings, was $7,083,600,000 with an average value of $1,126 per farmhouse. The median value of owner-occupied farmhouses for the entire country was $1,135 and the median value for tenant-occupied farmhouses was less than $500. Bearing in mind the difficulties cited above in comparing the values of farm and city dwellings, it is interesting to note that in 1930 when the median value of owner-occupied farmhouses was reported by the census to be $1,135, the median value of owner-occupied nonfarm homes was $4,778, or more than four times as great.

There are important differences in the value of farm homes in different regions of the country. Farmhouses of very low value are general throughout the South. In Arkansas, Louisiana, Mississippi, Alabama, and Georgia the average value of farm dwellings, per farm, is less than $500, while in all other Southern States, except Virginia, the average value was under $1,000.

Tables A and B, in the Appendix to Part I, give the distribution of owner-occupied and tenant housing by value groups for each census region in 1930.

Ratio of Rooms to Occupants.—A yardstick of housing conditions which is frequently used in urban housing surveys, the ratio of rooms to the number of occupants, or the index of crowding, is also applicable to farm housing. This ratio is based upon all rooms in the house except bathrooms and halls, and does not merely refer to the number of bedrooms. Students of housing have generally considered that a ratio of less than one room per occupant constitutes overcrowding. For example, the minimum requirements for a farm home as published and recommended by the Department of Agriculture in Miscellaneous Publication No. 479, Minimum Requirements for Farmhouses, provides for a minimum of five rooms for a typical farm family including both boys and girls. This minimum dwelling, according to the Department's recommendations should have three bedrooms and either a kitchen and a living room, with dining space included in one or the other, or one very large room for cooking, eating, and living space. Thus the minimum space requirements considered necessary for "decent and respectable living" allows for about one person per room.

Table 1 below shows the average sizes of farmhouses, sizes of families, and the average number of occupants per used room, for the United States as a whole and for census regions.

TABLE 1.—*Size of house, room use, and number of occupants*

Division	Rooms per house (average)	Unused rooms per house (average)	Used rooms per house (average)	Occupants per house (average)	Occupants per room used (average)
	Number	*Number*	*Number*	*Number*	*Number*
United States	5.4	0.2	5.2	4.6	0.88
New England	8.9	.5	8.4	4.4	.52
Middle Atlantic	8.6	.6	8.0	4.4	.55
East North Central	6.9	.4	6.5	4.3	.66
West North Central	6.0	.3	5.7	4.5	.79
South Atlantic	5.2	.2	5.0	5.2	1.04
East South Central	4.4	.1	4.3	4.8	1.12
West South Central	4.2	.1	4.1	4.6	1.12
Mountain	4.5	.2	4.3	4.5	1.04
Pacific	5.4	.2	5.2	3.9	.75

Source: The Farm Housing Survey (1934).

The averages used in table 1 tend to conceal the extent of crowding, and especially its concentration in certain regions and among certain groups of farm people. Table 2, which follows, reveals this a little more clearly. The tabulations for the southeastern region and the different groups of people listed show from 27 to 53.9 percent are living under crowded conditions. Another area, the Colorado-Montana-South Dakota region, shows nearly 18 percent living in crowed conditions. The prevalence of crowding indicates a moderate need for larger houses in all regions and an urgent need in the three southern regions and the mountain area if adequate and wholesome living conditions are to be achieved. The crowded conditions in the South are not quite as serious as the figures indicate, for the milder climate permits more outdoor living than is possible in the colder regions.

TABLE 2.—*Farm housing—Living quarters* [1]

Locality	Average number of rooms in house	Families occupying houses with 3 rooms or less	Families having more than	
			1 person per room	1.5 person per room
	Number	*Percent*	*Percent*	*Percent*
New England	9.35	0.8	0.8	0.2
Pennsylvania-Ohio	8.55	.2	3.3	.4
Michigan-Wisconsin	8.03	.8	4.7	.5
Illinois-Iowa	6.76	1.3	6.6	1.1
Kansas-North Dakota	6.27	5.6	7.8	1.6
Colorado-Montana-S. Dakota	5.06	17.7	17.7	5.7
California	5.58	4.2	5.1	.6
Washington-Oregon	5.64	5.6	4.4	.8
Southeast:				
White operators	5.28	11.0	27.0	8.4
Negro operators	4.11	30.8	47.2	21.4
White sharecroppers	4.21	29.6	41.8	15.5
Negro sharecroppers	3.70	42.6	53.9	23.0

[1] Data from the Consumer Purchases Study conducted in 66 counties in 21 States 1935–36.

The index of persons per room, of course, is not a complete measure of overcrowding, especially for large families. In the most overcrowded farm homes there is seldom a kitchen and a living room, and one small room must serve for cooking, eating, living, washing clothes, and other phases of work. In table 2 it is shown, for example, that 17.7 percent of the farm families in Colorado, Montana, and South Dakota occupied houses with three rooms or less and in the Southeast 42.6 percent of the Negro sharecroppers lived in houses of three rooms or less. Many of these families are large, some of them far above the average.

Conditions of Houses and Repairs Needed.—The Farm Housing Survey of 1934 revealed for the first time how poor was the general state of repair of American farm homes. If figures in the sample are extended to the 7,360,212 occupied farm homes reported by the 1935 census, it is indicated that 15,200,000 major repairs were needed, or an average of more than 2 per house. Needed major repairs reported in the survey included: foundations, 26.9 percent; walls, 19.3 percent; roofs, 26.6 percent; chimneys, 16.1 percent; doors and windows, 23.8 percent; screens, 20 percent; paint, 21.9 percent; interior walls and ceilings, 28.1 percent; floors, 19.9 percent; and stairs, 3.9 percent.

An index of the condition of farm homes prepared from the Farm Housing Survey is given in table C in the appendix. This index is an average of the number of cases reporting good condition for any one of the seven structural items appraised, expressed as a percentage of the total number of such structural items in each geographical unit. On this basis with an index value for the United States of 44, the West-South Central region has the lowest value of 33, and the Middle Atlantic the highest of 72. It will be seen that at one extreme the need for repairs was comparatively small in New England and Middle Atlantic, and that at the other end of the scale an acute need for repairs existed in the South Atlantic and South Central States. The three States for which the 1940 census tabulations are complete—North Dakota, New Hampshire, and Mississippi—indicate that the condition regarding repair has not improved materially since 1934. In fact, if anything, these preliminary census figures for three States imply that farm homes are in a worse state of repair in 1940 than they were in 1934 when the Farm Housing Survey was made, a condition which is supported by the fact that the value of farm dwellings has further declined in the decade between 1930 and 1940.

Data on the condition of farm service buildings, such as barns, cribs, silos, sheds, etc., are not as adequate as that on farm dwellings, but there are indications that even though farm service buildings are often kept in better repair than the houses, expenditures in recent years have not been sufficient to maintain them in good condition. Expenditures for farm service buildings declined from a high of $545,000,000 in 1919 to a low of $71,000,000 in 1932, a very large decline even after allowing for the drop in prices. In the 6-year period from 1935 to 1940, inclusive, the average spent for this purpose was about $213,000,000 a year. This volume of yearly expenditure indicates that there probably has been no general improvement in the condition of service buildings since 1934, when a survey made in connection with the farm housing survey showed that there was need for new buildings, other than dwellings, on 2,170,000 farms. It has been estimated that approximately 3,000,000 new service buildings are needed at the present time and that there is an average annual need for about 700,000 for replacement.

Factors in the Rural Housing Problem

Low income, Overpopulation, and Tenancy.—Low income is probably the largest single factor in substandard rural housing, just as it is in urban housing. In general, there is a direct correlation between the level of farm housing and the distribution of farm income. The regions with the poorest housing are those with the lowest farm incomes; and within any one region tenants, sharecroppers, and farm laborers usually have incomes lower than owner-operators and as a rule occupy the poorer houses in the communities.

Thus, while urban housing has the problem of slum clearance, rural housing has the question of tenancy. Since some 40 percent of the farmers of the United States are tenants, their housing conditions make up a very large part of the farm housing problem; tenancy also tends to be concentrated in low-income areas such as the South.

A factor which probably accounts for a considerable proportion of the difference between tenant and owner housing, is not susceptible to statistical measurement, but is readily observable and not difficult to explain.

The prevailing tenant system in most parts of the country is based on a verbal 1-year lease, high annual turn-over of tenants, and no provision for compensating the tenant for improvements he has made in the property, either in the land or the buildings. It is estimated that nearly one-third, or about 1 million, of farm tenant families move every year to other farms. Under this system there is little inducement for either the landlord or the tenant to care for or improve the farm and farmhouse and, in addition, the cost of moving places an additional drain on tenant incomes already low. Stabilization of tenancy through long-term written leases and programs for assisting tenants to become owners are thus seen to offer significant opportunities for the improvement of rural housing as well as for the promotion of soil conservation and other activities important to rural welfare.

Migratory Labor.—The lowest standard of living and of housing and sanitation of any rural group is that of the migratory farm laborers. Estimates of their number in recent years vary from 300,000 to 500,000 families. Their housing and sanitary facilities fall far below the worst levels found among any other groups in the United States. They cannot be measured in terms of the yardstick set up in the Rural Housing Survey for their value is close to zero and they lack practically every convenience. Housing is one of the greatest needs of this group, but the problem is obviously far bigger than this. Even the housing aspect of the problem has hardly been touched. The migratory labor camps constructed and operated by the Farm Security Administration, for example, can now provide shelter for a maximum of only some 19,000 families at any one time.

Sanitary Facilities on Farms.—Environmental sanitary facilities as discussed here are confined to three major requirements relating to the health of the farm family: proper means of sewage disposal; protection of the domestic water supply against contamination and pollution; and screening or mosquito-proofing of dwellings.

Although there is a very close relationship between environmental sanitary facilities and the health of farm and rural people, it is difficult to portray this relationship by means of the vital statistics of the Nation. For example, it is known that there are several million cases of malaria each year in the United States, but the number of deaths reportedly due to this disease is small, possibly numbering 3,000. The economic loss due to illness from malaria, however, is enormous because of the time lost from work by individuals suffering from the disease. Hookworm is another disease causing a high economic loss in certain areas, but the records do not show a high mortality rate. Typhoid fever, of course, does have a high mortality rate; and although the number of "carriers" of this disease is definitely on the decrease it has been noted that when a "carrier" of the germ does appear in rural areas there frequently follows an explosive outbreak of typhoid fever because of the lack of adequate sanitary facilities.

The extent of the public interest in rural sanitary facilities for public health and other reasons can be measured in part by the Government programs now in operation in this field. Public health services maintained by local and State governments with financial aid from the Federal Government generally provide for free technical service in testing water supplies and other sanitary facilities. Under the CWA, ERA, and WPA work programs of the last several years some 3,000,000 sanitary privies were constructed in rural areas, according to estimates of the U. S. Public Health Service. The Farm Security Administration has also aided some 80,000 low income farmers through its environmental sanitation program. By means of small loans and grants and maximum use of the farmers' own labor, some 72,000 sanitary privies, 32,000 safe water supplies, and screening on 38,000 dwellings were provided during the period 1937–41.

It is not possible to set up minimum standards for sanitary facilities on a national basis, as has been done for housing in the Department of Agriculture publication on Minimum Requirements for Farm Housing, because the regulations of State health departments vary considerably. In general, however, it can be said that sewage disposal should be by means of a septic tank when running water is available, or by a sanitary pit privy when it is not. Recommended practices for water supply provide for enclosure with impervious building material to exclude all forms of contaminating or polluting material and means for the withdrawal of water without permitting contamination of the water supply. All natural openings, such as doors and windows, should be covered with galvanized or bronze screen wire, 16 meshes to the inch, all other openings into the house, such as cracks in the floors and walls, should be fully closed, and in malarial areas chimney vents should be covered with 16-mesh screen wire during the summer months.

The Farm Housing Survey of 1934 is also the best source of data on the sanitary facilities in farm homes in the United States, but is less satisfactory than for most other housing conditions. The Survey shows the facilities existing on farms in 1934 but does not reflect whether or not the water supply was protected or whether the method of waste disposal was satisfactory from a sanitary and health point of view.

Tables D and E, in the Appendix to Part I, show the condition of farmhouse improvements relating to sani-

tation as revealed by the Farm Housing Survey. A few highlights may be presented here. Over 83.6 percent of the farm homes lacked running water; in 72 percent, water was carried in by hand from an average distance of 250 feet. Nearly 27 percent had no screens and only 31.4 percent had good screening. Over 13 percent did not even have outdoor privies. Nine percent had indoor toilet facilities, but only about half of these were connected with septic tanks; the remainder used cesspools or discharged directly onto the surface or into a stream.

By supplementing the data in the Farm Housing Survey on the nature of existing facilities with the results of various local surveys on the adequacy of existing facilities, it is possible to make estimates of the number of farm homes in the country in which sanitary facilities fall below minimum standards of health. One such estimate, prepared in the Department of Agriculture in connection with its work on post-war planning, is that 66 percent of the farms in the country are in need of some screening or mosquito-proofing, 92 percent of domestic water supplies require some improvement; and 75 percent need improvement in water disposal, including 56 percent which need sanitary privies and 19 percent which need septic tank installations.

A Potential Program

The foregoing discussion of the nature of the farm housing question will have served to indicate some of the difficulties of presenting a potential program of rural housing in quantitative terms. There is not now any rural housing program as such; factual information and administrative experience are both rather limited; and the problem of housing cannot readily be isolated from the complex pattern of rural and agricultural problems for special treatment. All of these factors stand in the way of presenting the rounded picture implied in the word "program." About all that can be done is to set forth certain estimates of improvements which appear to be needed.

Probably the most clear-cut method of measuring the need for and the potential magnitude of a program for improved rural housing would be to assume a minimum standard such as the "Minimum Requirements for Farmhouses" of the Department of Agriculture, and set forth what would have to be done to bring existing housing upon that level. Unfortunately, existing statistical information does not permit such a calculation, and rough approximations must be made by other methods. A housing program of the magnitude suggested in the rough estimates which follow would probably not bring all farm housing up to the level of the "Minimum Requirements for Farmhouses."

The data in the Farm Housing Survey indicated a need for 15,200,000 major repairs to farmhouses. These figures on the need for repairs do not, of course, reflect directly the amount of construction needed to bring existing farmhouses up to minimum standards. For example a new roof may be needed for a two-room shanty housing a family of five or six. The cost of providing a minimum standard of housing for this family would not be $100 for a new roof but the construction of an entirely new five- or six-room house.

Data in a supplementary survey made in connection with the Farm Housing Survey of 1934 on the need for additional rooms to alleviate crowding provides another rough measure of the magnitude of possible programs. At that time over 4 million additional rooms were desired by farmers.

This same supplementary survey also gives some indication of the need for new houses in 1934; 697,000 farmhouses were, in the opinion of their occupants, beyond repair and in need of replacement. In the last 6 years there has been a decided lag in the building and repair of rural homes. It has been estimated that construction in this period has probably fallen short of the normal replacement by more than 50,000 houses a year. If a cumulative deficiency of 300,000 for the 6-year period is added to the 697,000 farmhouses, which in the opinion of the occupants were beyond repair and in need of replacement in 1934, we have an indication that at least 1,000,000 farmhouses were in urgent need of replacement in 1940. If a quite modest level of housing were to be assumed, the need for new farmhouses might be found to be two or more times as great as the million indicated. Edith Wood, in the book Introduction to Housing,[1] estimates that two-thirds of all farm homes are substandard.

Experience of the Farm Security Administration in the tenant purchase program indicates that minimum standard five- or six-room houses based on standard designs could be built in 1940 for a retail price of about $1,250 in the South. Costs were somewhat higher in the North. In the first 2 years during which tenant purchase loans were made, 2,096 new homes were built at an average cost of $1,313.

Preliminary estimates of the need for the three principal sanitary facilities of sewage disposal, water supply, and screening for all farmhouses in the United States were prepared for use in connection with the post-war planning work of the Department of Agriculture. The estimates were based upon existing information, including the Farm Housing Survey and the experience of the FSA in its sanitation program. For any particular small area such estimates would probably not apply with any great accuracy, but taking the

[1] Federal Housing Administration, 1939.

country as a whole it is believed they fairly represent the need for environmental sanitary facilities. The estimated need is for some screening on 4,001,000 farms, repair of water supplies on 5,557,000 farms, installation of septic tanks on 1,139,670 farms, and construction of sanitary privies on 3,404,100 farms.

Evaluation Considerations and Principles

General Considerations and Relationships

Better rural housing is a prime requisite of better health, morale and living on the farm for both present and future generations. Inasmuch as studies and data indicate that a considerable proportion of our farm people are living under poor if not deplorable housing conditions, it would seem that the provisions of at least a minimum level of housing for all would result in large social benefits.

For purposes of evaluation, the benefits of rural housing are to be compared with the benefits of such activities as education, nutrition, and medical care. The benefits from these lie in improving the well-being of man through the provision of minimum facilities for direct use or consumption. This is in contrast to such activities as soil conservation and land development which are designed to increase the productive capacity of the soil. Better rural housing cannot be justified in terms of maintaining or increasing productive capacity, except insofar as well housed and healthy people may be more efficient in production.

It must, however, be recognized that the purpose of greater productive capacity is a better level of consumption; and we must be careful to avoid the conclusion that benefits result only from increasing productive capacity. A major problem, in fact, is to effect such a balance in the use of the nation's savings between improving consumption standards and improving productive capacity as will yield a maximum over-all satisfaction.

In addition to comparing the need for the consumption and welfare group of activities generally with the need for the production and resource improving activities, it is necessary to compare the need for rural housing with the need for such other welfare needs as food, clothing, education and medical care.

When a program for improving rural housing in specific areas is considered, the capacity of such an area to provide permanent support for population should be borne in mind. An adequate appraisal of the land as to its agricultural and economic possibilities, including new possibilities that might result from land improvement and development, should accompany any publicly aided housing program.

Some of the improvement of housing may be planned as part of other programs—as for example in the settlement of new irrigated areas or in making farm ownership possible for tenants in the Tenant Purchase Program. In these programs, as well as where direct measures to improve housing are contemplated, it will be desirable to inquire into the nature of the agriculture of the region and to determine whether changes are likely to come about either through natural causes or by public action which would cause the housing to go unused or to make it difficult to pay for. In self-liquidating programs these questions will tend to be examined in determining the soundness of the loan. They should be at least as closely examined in subsidy programs because areas in which subsidies are necessary are likely to be those nearest to the economic margin.

Consideration such as this would seem to suggest a policy of "to him that hath shall be given," and of withholding improvement in housing from those who need it most. This should not be the case where there is every indication that despite the poverty of land resources that people will continue to live there for many years to come. In these situations, minimum housing may properly be provided. Moreover, there is much to be said for a comprehensive program of rural sanitary facilities in all areas of the country as a health measure.

Costs and Benefits

Since the farmhouse is so largely a part of the farm enterprise, the public aspects of farm housing are likely to consist largely of credit or assistance to private owners. To the extent that the public assistance to farm housing consists of self-liquidating loans the problem of evaluation of specific projects does not arise. If loans are made at interest rates below those at which the Government can borrow and up to 100 percent of the equity they could not be considered completely self-liquidating in a business sense. To the extent that a housing program involves subsidies the problem of social benefits becomes significant. A subsidy assumes corresponding social benefits.

In the present Federal programs that are wholly or in part concerned with housing, both urban and rural, there are a number which were established as self-liquidating, including FHA guaranteed mortgages, HOLC loans, loans of the Farm Credit Administration, and Tenant Purchase loans. There are also a number of Federal programs which are recognized as involving some degree of public subsidy. Included in this category are the USHA program and the migratory labor camps of the Farm Security Administration. The USHA program involves only a partial public subsidy. Migratory labor camps have been financed entirely by the Federal Government.

The common characteristic of both these housing programs involving subsidy, one largely urban and one

rural, is that they are both designed to help the lowest income groups in both areas by providing a minimum standard of housing to needy people. The benefit of providing housing facilities to people in accordance with their needs and somewhat beyond their ability to pay, is the value which society places upon such provision. If society, through legislation or other expressions of public opinion, sets a minimum standard of housing which it believes all people should have in the interest of the general welfare, it must be tentatively assumed that the social benefits are at least equal to the public costs of providing that minimum. The task of determining whether the social benefits are as great as the costs for proposed rural housing programs would thus become, in part, a matter of ascertaining the wishes of the Nation's people. The proportion of social benefits that can be allowed for rural housing generally or for general classes of rural housing might be determined as a result of the general judgment made.

In evaluating a specific housing proposal involving a subsidy, it would be necessary to see whether it provides for minimum needs at as low a cost to the Government as other proposals.

The principle of maintaining minimum standards of living by the distribution of Government aid on the basis of need and ability to pay underlies quite a number of Government activities, most of them within the general field of "health and welfare." Among these are public health activities, and the food-stamp plan. In other fields of Government activity, many of them of very long standing, this principle of minimum standards has been carried to the extent of removing functions almost entirely from the sphere of private economic activity and providing it as a public service to all. In this category are education and police and fire protection.

Because of the very close tie between farm housing and the economic enterprise of farming, it will frequently be more satisfactory and less costly to provide improved housing in connection with a program to increase income. To use a specific example, to provide a minimum standard of housing to low-income farmers on poor land or inadequate acreages would be costly and would tend to improve only one element in their standard of living. To help these same farmers to acquire an adequate-sized farm with good land may enable them to increase their incomes sufficiently to pay for better housing and to raise the other elements in their standard of living as well.

Distribution of Costs

As indicated above, the consideration of costs and benefits and methods of financing are very closely related in rural housing programs. For programs which are self-liquidating, the question of measuring benefits does not arise in an acute form; for programs which involve a Government subsidy the question of financing must be considered in relation to the nature and distribution of the benefits.

If it is determined, in the interest of the health and welfare of low-income groups, both urban and rural, that a governmental housing subsidy of some kind is desirable, there then arises the further question of how the subsidy shall be distributed among the several levels of Government—Federal, State, and local. Are the benefits of health and welfare through improved housing of local, State, or national significance? Obviously they are significant at all three levels. In other fields of a similar character, such as public health, education, and public assistance there is a wide divergence of financing methods, which are largely the result of historical development rather than any weighing of benefits. For example, in education which has been a local responsibility from a very early date in American history, local financing is still of major importance. The State governments have given increasing financial aid in this field; but the Federal Government has not yet come to contribute appreciably to the costs of general education, although this step has been urged. In the field of public health activities, all three levels of government are now contributing to the cost. In public assistance—old-age assistance, aid to the blind, and aid to dependent children—the Federal Government bears half the cost and the State and local governments divide the other half in varying proportions in the different States. General relief is now entirely financed by local governments with some assistance from State governments. In recent years, about 75 percent of the cost of work relief has been borne by the Federal Government and about 25 percent, in the form of a sponsor's contribution which is largely in materials and equipment, by local and State governments.

In the two subsidized housing programs which have been treated as examples, USHA and migratory labor camps, the Federal Government has borne most of the subsidy costs. In the USHA program, local governments are required to bear one-fifth of the cost of the annual subsidy, which is usually accomplished through local tax exemption. The local housing associations are also required to finance at least 10 percent of the development cost of each project, the remainder being financed by loans from the USHA. In the migratory labor camp program the total cost is borne by the Federal Government.

In the field of farm housing it seems probable that the Federal Government will play a major role in any future housing program, both as a banker in loaning funds at relatively low interest rates and in contributing

subsidies. The field is by no means closed to State and local governments, but the trends of the last two or three decades would indicate that these levels of government are contracting rather than expanding their programs involving credit and other types of financial assistance to the farmer. Twenty or twenty-five years ago some States, particularly in the West, had some rather important credit programs, but all the major governmental farm credit activities are now Federal.

In the absence of any well-developed criteria for financing possible farm housing programs, either with respect to the proportion of the cost to be borne by the public or the distribution of public costs among levels of government, it may be useful to summarize briefly certain general principles which have evolved out of the embryonic farm housing activities which have been carried out by the Federal Government during the past several years, largely by the Farm Security Administration.

1. Self-liquidation has been an important guiding principle in these activities. It may be noted that future programs based on this principle would probably not result in a very large volume of activity. Such programs would not meet the tentatively estimated needs presented in the preceding section on the potential volume of rural housing improvements. It is likely, however, that the construction of groups of houses rather than scattered single units and the utilization of the farmers' own labor would reduce costs and thus enlarge the potential field of self-liquidating programs. Reduction of costs and the need for skilled labor through wider adoption of prefabricated housing might also enhance the possibilities of meeting rural housing needs.

2. Subsidies are extended only to the lowest-income families, and are directed particularly at the correction of conditions which are seriously detrimental to health. Of all housing activities, sanitation programs should probably be among the very first to be subsidized.

3. In order to spread the benefits of available funds as widely as possible, it is suggested that only minimum farm housing be constructed with the aid of subsidy. Fixed limitations might be useful, perhaps an everage cost of $1,500 per house in the South and $2,500 in the North (in terms of 1940 prices). These limits would not apply, of course, to types of housing which do not require direct subsidy.

Different procedures and methods of financing would be required to provide improved housing for different groups of farm people—especially the three groups of owners, tenants, and laborers. Housing assistance to owners in connection with houses for themselves and their tenants may largely take the form of long-term, low interest credit and technical guidance. Farm laborers with relatively stable employment might through rentals be expected to repay the principal over a period of say, 40 years. Shelter and housing for migratory agricultural laborers tend to involve a 100-percent Government contribution on capital costs. To insure the provision of sanitary facilities of the minimum standard necessary for security of health to all farm families would probably require Government assistance on a sliding scale ranging from 100-percent subsidy for the lowest-income group to no subsidy but low interest loans for the highest-income group.

Timing

The actual construction period is quite short for both housing and sanitary facilities and from this point of view there would be considerable flexibility in expanding and contracting programs in the interest of employment stabilization. On the other hand, the fact that these programs involve a considerable financial contribution from private individuals imposes distinct limits upon the rate of expansion. Farmers cannot be expected to sign contracts as soon as public funds become available for expanded programs. Moreover, the periods of economic depression and unemployment in which programs are likely to be expanded to provide employment are the very periods in which private individuals are hesitant about making new financial commitments. Housing and sanitary facilities are also more economically provided through the group approach rather than by working with scattered individuals. If a group of 50 or 100 farmers in the same locality participate in a program, substantial savings are possible by purchasing materials in large lots and in cutting and processing the materials at one central spot. Participation, especially group participation, takes time to develop.

An important consideration is the fact that a good many programs involve the improvement of farm housing to some extent, but are not directed solely or primarily at this objective. In the Tenant Purchase Program, for example, the primary objective is the promotion of stable ownership of family-sized farms and the reduction of tenancy. Only about 20 percent of the amounts loaned are expended for new housing or the rehabilitation of old housing. It would seem that in programs of this type, the timing of loans should be based largely on the requirements of the primary objective rather than the employment afforded by the housing construction incidentally involved.

Considered together these factors suggest that programs involving farm housing and sanitation offer some possibilities of expansion and contraction in the interest of employment stabilization, but that their flexibility is not nearly so great as the short period of construction would suggest.

APPENDIX

TABLE A.—*Owner-occupied farm homes by value groups, by regions, 1930*

Division	All homes on farms operated by owners or managers	Number of homes valued at—							Value not reported	Median value
		Under $1,000	$1,000 to $1,499	$1,500 to $1,999	$2,000 to $2,999	$3,000 to $4,999	$5,000 to $7,499	$7,500 to $9,999	$10,000 and over	
United States	3,624,283	1,589,990	554,824	359,149	482,438	337,894	112,358	20,368	22,108	145,154	1,135
New England	117,040	27,098	19,715	14,090	21,539	18,382	7,915	1,653	1,928	4,720	1,832
Middle Atlantic	305,148	54,966	53,968	39,396	65,476	51,739	20,173	3,852	4,932	10,646	1,986
East North Central	702,525	201,574	131,705	94,812	135,345	87,825	23,542	3,467	2,933	21,322	1,539
West North Central	668,586	203,662	117,383	84,414	118,256	88,032	29,504	4,781	3,058	19,496	1,521
South Atlantic	548,894	324,034	74,112	39,774	43,429	27,475	10,163	2,327	3,454	24,126	782
East South Central	468,236	343,714	48,580	21,159	20,499	11,762	4,080	899	1,310	16,233	512
West South Central	415,903	263,036	55,574	29,407	28,222	15,062	4,204	879	1,108	18,411	711
Mountain	182,488	97,391	22,581	13,547	16,990	11,626	3,628	611	714	15,400	806
Pacific	315,463	74,515	31,206	22,550	32,682	25,991	9,149	1,899	2,671	14,800	1,414

Source: U. S. Census.

TABLE B.—*Tenant-occupied farm homes by value groups, by regions, 1930*

Division	All tenant farm homes	Number of homes valued at—							Value not reported	Median value
		Under $1,000	$1,000 to $1,499	$1,500 to $1,999	$2,000 to $2,999	$3,000 to $4,999	$5,000 to $7,499	$7,500 to $9,999	$10,000 and over	
United States	2,664,365	1,742,551	233,061	137,155	159,576	87,773	21,715	3,088	2,398	277,048	(1)
New England	7,885	2,038	1,219	822	1,241	1,008	418	75	66	998	1,613
Middle Atlantic	52,455	7,996	8,652	6,517	11,417	8,973	3,099	481	508	4,812	2,058
East North Central	263,977	72,094	51,044	37,019	50,643	29,015	6,637	790	577	16,158	1,510
West North Central	444,169	165,611	83,141	55,849	65,414	34,270	7,684	961	515	30,724	1,247
South Atlantic	509,574	401,708	26,302	10,570	9,403	4,966	1,487	283	310	54,545	(1)
East South Central	593,978	493,533	14,753	5,228	4,390	2,144	621	120	113	73,076	(1)
West South Central	687,231	543,390	33,723	13,053	8,464	2,925	597	153	124	84,802	(1)
Mountain	58,826	34,736	7,353	3,941	3,785	1,841	463	69	62	6,576	682
Pacific	46,270	21,445	6,874	4,156	4,819	2,631	709	156	123	5,357	952

[1] Less than $500.

Source: U. S. Census.

TABLE C.—*Condition of houses for 10 structural items and index of their condition. 1934*

Division	Structural items found in poor [1] condition										Index of condition of houses [2]
	Foundation	Exterior walls	Roofs	Chimneys	Doors and windows	Screens	Exterior paint	Interior walls and ceiling	Floors	Stairs	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
United States	26.9	19.3	26.6	16.1	23.8	20.0	21.9	28.1	19.9	3.9	44
New England	6.9	6.2	8.4	3.9	4.3	6.5	19.6	10.1	6.6	3.0	70
Middle Atlantic	5.9	6.8	11.7	4.3	6.4	18.8	31.6	13.4	6.9	3.6	72
East North Central	15.4	11.7	16.3	6.6	12.5	20.1	30.0	16.0	11.8	5.1	56
West North Central	20.6	12.5	18.7	8.3	15.8	22.5	28.5	19.1	15.2	6.2	54
South Atlantic	34.5	25.4	33.7	17.6	33.1	14.4	16.9	37.4	26.5	4.3	36
East South Central	30.4	22.7	31.8	18.7	30.7	18.2	15.8	34.2	21.7	3.0	36
West South Central	36.7	27.3	36.1	32.2	33.4	27.0	17.4	37.0	26.2	1.1	33
Mountain	28.1	19.2	27.6	15.6	20.0	24.0	26.6	28.0	23.4	3.2	46
Pacific	21.0	11.2	18.8	8.7	9.7	14.6	25.1	20.0	14.0	3.9	57

[1] "Poor" is defined as "in need of repair."

[2] The *index* of condition is an average of the number of cases reporting good conditions for any 1 of 7 structural items, expressed as a percentage of the total number of cases in each geographical unit. The seven items are foundations, exterior walls, roofs, chimneys, doors and windows, interior walls and ceilings, and floors.

Source: The Farm Housing Survey (1934).

TABLE D.—*Lack of improvements in farm homes, 1934*

Division	Farm homes without the following improvements								
	Bathrooms	Running water	Water in house [1]	Indoor toilets	Any toilet facilities [1]	Screens	Adequate screens	Paint	Adequate paint
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
United States	85.5	83.6	73.0	91.0	13.5	26.8	68.6	40.0	82.6
New England	67.0	44.8	16.0	68.0	10.6	4.3	26.6	8.9	62.5
Middle Atlantic [2]	56.7	46.0	15.0	62.2	Few	.4	32.4	5.1	60.1
East North Central	83.2	81.9	71.0	88.5	Few	8.2	56.9	14.8	75.4
West North Central	83.4	84.2	76.0	90.1	Few	7.0	57.6	12.2	71.8
South Atlantic	92.2	91.1	81.0	95.0	19.3	50.6	80.8	59.9	90.1
East South Central	95.2	95.9	70.0	97.4	46.2	44.1	80.1	62.2	90.6
West South Central	88.7	86.9	83.0	96.3	16.9	32.2	78.6	58.4	89.2
Mountain	79.8	73.2	66.0	87.8	Few	12.4	61.0	34.7	82.3
Pacific	42.9	30.1	25.0	58.3	Few	13.9	51.4	22.9	74.5

[1] Approximate figures.

[2] New Jersey only.

Source: The Farm Housing Survey.

TABLE E.—*Water supply and sewage disposal, 1934*

Division	Percentage of homes having the following								
	Water by		Kitchen sink and drain	Bath equipment			Septic tanks [1]	Cesspools	Ratio of septic tanks to toilets
	Hand pump	Pipe		Lavatory	Tub	Flush toilet			
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
United States	14.0	16.4	28.4	8.9	11.2	8.5	4.5	7.9	53
New England	28.9	55.2	96.1	27.8	29.9	29.4	9.6	26.1	33
Middle Atlantic	31.3	54.0	69.7	38.8	41.9	37.5	10.4	34.0	28
East North Central	34.9	18.1	55.1	10.7	13.5	10.3	5.6	12.2	54
West North Central	23.7	15.8	37.5	9.5	12.8	8.8	4.1	13.1	47
South Atlantic	10.1	8.9	12.4	4.9	5.5	4.9	2.8	2.7	57
East South Central	2.7	4.1	5.4	2.6	3.0	2.5	1.0	.8	40
West South Central	1.9	13.1	10.9	4.6	7.3	3.6	1.8	3.2	50
Mountain	5.9	26.8	31.1	12.6	15.3	11.9	4.6	16.8	39
Pacific	5.6	69.9	75.0	40.4	51.0	41.5	28.3	25.0	68

[1] Cesspools sometimes confused with septic tanks.

Source: The Farm Housing Survey (1934).

PART II—PUBLIC WORKS AND RANGE LAND[1]
1. THE NATION'S RANGE LANDS

Range lands cover one-half the area of continental United States or approximately 970 million acres. They are made up of approximately 728 million acres in the West; 40 million acres in the North and East, including the Ohio and Mississippi basins; and some 200 million acres of woodland pasture and other native forage-producing lands of the South. In addition, some 200 million acres within territorial possessions are available for grazing use.

Character

Range lands are considered to be those lands producing uncultivated forage, primarily native grasses and other forage plants, suitable for grazing by domestic livestock. They consist mainly of lands which, because of rough topography, poor or unsuitable soil, relatively meager precipitation or other adverse climatic conditions, lack of irrigation water or other conditions, cannot successfully be used permanently for cropland agriculture. Range land also includes forage-producing forest lands which can best serve the Nation's welfare through use by domestic livestock in addition to the production of timber or other forest products and other services.

Ownership

Approximately 610 million acres, or 63 percent, of the range land is privately owned. Of the other 360 million acres about 295 million acres are Federally owned or controlled, with the remainder in State and county ownership. Federal range lands are considered to include those in national forests, grazing districts, land-use projects, Indian reservations, and a number of other Federal reservations.

The private lands include the unimproved native grazing lands on farms and ranches and the holdings of railroads, lumber companies, and other corporations which are usually leased for grazing to local farmers and stockmen.

[1] This statement was prepared under the direction of a committee consisting of A. D. Molohon, Grazing Service, chairman; W. R. Chapline, Forest Service; F. G. Renner, Soil Conservation Service; and G. E. Weaver, Agricultural Adjustment Administration. Contributions were made by C. A. Connaughton and E. D. Sanvig, of the Forest Service; H. M. Bryan, of the Grazing Service, and T. N. Winn, of the Soil Conservation Service.

Uses

The function of the vast range resource in terms of the national economy is difficult to comprehend because of its very magnitude. The chief function of the range is furnishing feed for livestock, but to realize its full significance several of its other services also must be recognized. Range land, for example, provides a home for great numbers of wildlife; it is vitally important as watershed land; it provides a great area for various kinds of outdoor recreation; and it supplies many lesser products and services common to wild land.

Livestock Production

The Nation's range lands support a livestock industry that forms the hub of an integrated farm and ranch industry valued at 13 billion dollars in the West alone. These lands support for some part of the year about 73 percent of the sheep and goats of the nation and 53 percent of the beef cattle, as well as numbers of other livestock. From the range land territory comes more than 80 percent of the nation's wool and 40 percent of the meat and hides. It is in the range territory that a large portion of the feeder livestock is produced for fattening on farms in the Corn Belt and other fattening areas of the country.

Livestock production on range lands, together with the growing of correlated farm products, is important to a large proportion of the population of the West, and to a considerable proportion of the farm population in the central and eastern States. In the Ozarks and the South, range livestock production means much to the welfare of the people of these regions and offers considerable opportunity for needed agricultural diversification.

Water Delivery and Erosion Control

The herbaceous and other range plants making up the vegetal cover on range land are the major factors in control of erosion on such lands and in satisfactory water delivery to distant places.

A large portion of the range area that is within important drainage contributing water to a 6 billion dollar irrigation farming business is grazed. Also, many cities and towns derive their water supply from these watersheds. A comprehensive study of the Nation's resources dependent upon water storage has never been made, but rough calculations of Federal, State,

municipal, and corporate expenditures for reservoir and auxiliary facilities and similar estimates of the aggregate value of dependent private holdings easily run into many billion dollars.

Wildlife and Recreation

The major part of the forage for the Nation's big game herds comes from the range lands. Incidental to their use in the production of livestock and livestock products, range lands and the streams which traverse them are productive of wildlife values in the form of meat, fur, and fish. One of the intangible but chief values of wildlife is the increased recreational attraction and enjoyment which it affords.

These various products and services of the range combine in widely different ways and with much different emphasis throughout the Nation. Because of this diversity any discussion of the range resource can be made most conveniently on a regional basis, combining areas of similar problems and characteristics. For this report the country has been divided into three broad regions: the West, the South, and the Northeast; brief reference only is made to the territories.

The Western Range

The Western Range occupies an area of approximately 728 million acres west of a north-south line bisecting the Dakotas, Nebraska, Kansas, Oklahoma, and Texas. This region occupies all or part of 17 western States and is the largest and the most important range area in the Nation.

Many divisions of the western range could undoubtedly be delineated but to keep them within practicable limits for discussion, only three are recognized: the Great Plains, the mountains, and the semideserts and deserts.

Great Plains

The Great Plains include an area of about 216 million acres, approximately 30 percent of the Western Range. The climate of this area is typically continental with wide extremes in temperature and precipitation, both reaching their peaks during the late spring and summer months. But the climate and topography are sufficiently uniform that the native vegetation is homogeneous to the point of monotony.

Only two native types of vegetation are important enough to merit consideration—the tall grass and short grass. Of these the short grass type occupies an area about ten times larger than the tall grass. This widespread type extends in a more or less continuous belt of varying width from central Texas north to Canada. Two sod-forming species—grama and buffalo grass—provide the bulk of the forage. Present forage yields are far greater in tall grass than in short grass types, although both provide excellent spring, summer, and fall and, under some conditions, year-long range.

Most of the range in the Great Plains is in private ownership but there are some rather large areas of public range in the Northern Plains. The principal kind of livestock is cattle. Some sheep are produced for feeders and replacements for breeding herds in the mountains. Here range and crop lands frequently are highly intermixed. Production is large per unit of area and operations are generally small. All this requires intensive management which necessitates a correspondingly large amount of improvements for most effective service.

Mountains

The mountain division of the Western Range includes five commonly recognized major types: bunchgrass, sagebrush,[2] pinion-juniper, chaparral, and open forests. Approximately 354 million acres are involved in these types.

Owing to the extreme variation in environmental factors influencing this general area, there is great diversity in vegetation and other range conditions. Certain types or portions of types such as the sagebrush-grass or pinion-juniper, are valuable chiefly for spring, fall, or winter grazing; others like the open forest type are usable mainly during the summer season. Some types under heavy grazing use are reverting to inferior grasses and weeds; others are reverting to inferior and dense stands of brush. In types like bunchgrass, extensive private ownership is common but in other types public ownership dominates.

In spite of this inherent diversity there is sufficient uniformity to warrant the grouping of range problems. Throughout the Mountain division, the livestock industry is organized on more or less the same basis: rather large areas are commonly required for individual ranch operation; generally speaking the same classes of livestock products are produced; marketing conditions and practices are similar; range management practices vary primarily in detail, with topography largely dictating seasonal use; multiple-uses and services of range land for watersheds, wildlife, and recreation are uniformly important; demand for range forage consistently exceeds supply; and universally grazing maintains a dominant place in the agriculture of the area. The demand on the range is great in all types, with all available forage utilized. Erosion from unwise use has been severe over large areas, resulting in damaging floods and silting of reservoirs.

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[2] The sagebrush type has characteristics of both the mountain and desert divisions but for convenience is discussed entirely under "mountains".

Semidesert and Desert

The semidesert and desert division of the Western Range occupies an area of about 158 million acres mainly in the southwestern section of the country. As the name implies, this division includes the more arid and generally less productive portions of the West. Three general types in this division are recognized: semidesert grass, salt-desert shrub, and southern desert shrub.

Of these types the semidesert grass is the largest and, generally, the most important. This type is commonly used yearlong, its productiveness depending largely on precipitation, which fluctuates greatly from year to year, and on past management practices. The salt-desert shrub type is not particularly productive and is used principally for grazing sheep during the winter. The southern desert-shrub type is probably the least important type of all the truly range types in the West. It is essentially desert, generally undependable, and of low grazing capacity. For a short period in winter and spring of most years annual plants furnish good forage, especially for sheep grazing. In general, where stock-water supplies have been available, these desert ranges have suffered rather heavily from past grazing use and, because of the delicate physiographic balance, serious accelerated erosion has developed on a large scale.

Land ownership throughout the semidesert and desert division is predominantly public, with private ranches primarily headquarters units. There are some successful large operations on privately owned land. In the semidesert grass type State ownership is particularly important in Texas and to a lesser extent in eastern New Mexico.

Western Range History

The first real use of the western range by domestic livestock began around the early Spanish settlement in the Southwest. It was soon apparent that the millions of acres of native grassland were particularly suited to cattle production. Beginning in Texas, cattle production spread with phenomenal rapidity throughout the West. It is estimated that by 1886 almost 22 million cattle were on the range in the 17 western States.

The cattle industry's first setback came with the severe winter of 1885–86 and with the droughts that followed. Lacking adequate feed and protection, cattle in many sections throughout the range area were nearly wiped out.

The losses sustained were costly and taught a valuable lesson. Specifically they indicated that a balance between range forage, winter feed and livestock numbers was essential to continued success of the livestock industry. Faced with this realization progressive livestock owners began to acquire or control land needed for grazing. They began to make improvements to facilitate range use and made some efforts at management of the range by control of numbers of livestock and other simple measures.

As the cattle industry began to level off, however, almost overnight an additional and complicating factor was introduced by the appearance of vast numbers of sheep on the range. It is estimated that in 1910, out of about 47 million stock sheep in the country 31 million were in 13 western States.[3] Range wars and feuds developed and violence flared. In the struggle to get the maximum possible use from the range, forage in many areas was seriously depleted and owners of both cattle and sheep suffered. Finally, after a period of uncertainty, compromises were forced on the industry and an ever-increasing harmony between conflicting interests began to develop.

More or less coincidental with the efforts at stabilization of the livestock industry came the homesteading boom and the diversion of much range land to farming. This movement further encouraged the stockman to consolidate and strengthen his enterprise by controlling adequate land. In some places it became a bitter struggle between settler and livestock operator to secure desired holdings. Under the homestead laws and the various other means of disposing of public lands, such as railroad grants and Spanish land grants, approximately 376 million acres or about 52 percent of the western range land passed into private ownership. By various processes, States and counties acquired about 65 million acres of grazing lands.

In direct contrast to laws which encouraged the passing of public lands to private ownership were the various Federal reservation acts. Under these acts unappropriated lands were set aside for public use in national forests, grazing districts, and other reservations. These public reservations together with lands purchased by the Federal Government in recent years, include some 290 million acres valuable for grazing.[4]

The variety of ownerships more or less intermingled over large areas and the hit-or-miss method by which these holdings were built up have given rise to some serious problems in the industry. First of all, intermingling ownership on open range makes management of the resource extremely difficult; second, the proper use of the resource is difficult of attainment because organization into effectively sized units is impracticable; and third, adjustments to improve range conditions are

[3] U. S. Dept. Agric., Bur. Agric. Econ., Agricultural Outlook Charts, 1940.

[4] Excluding Alaska.

very difficult to achieve where a complex pattern of ownerships and interests prevail.

Lessons of the World War I.—In the history of the western livestock industry, the boom during World War I and the depression which followed has unusual significance. Prior to the beginning of the war in 1914 cattle numbers had been gradually decreasing. The demand for range was diminishing and many needed adjustments were being made. Then came the demands for livestock products incident to the war activities, and in the effort to meet war needs, ranges were crowded with livestock. In the 17 western States cattle numbers increased from 26,041,000 in 1914 to 34,860,000 in 1918.[5] The number of stock sheep in the western States remained practically constant at about 27 million in the same period, though prices increased nearly threefold.

As a further disturbing feature the demands for grain increased sharply during the war and many acres of productive range, particularly in the Great Plains, were cultivated. During the period 1910 to 1929 it is estimated that 50 million acres of range land were plowed for dry farming and most of this was done after 1915.

In order to bring about the expansion of the livestock industry, credit was used extensively and frequently pyramided. Then came the post-war depression. The bottom dropped out of the market. Scoured wool prices dropped from $2.05 per pound in March 1920, to 26 cents per pound in August 1921. Cattle prices in Chicago dropped from more than $21 per hundredweight in 1919 to a little more than $9 in 1921. The result was a general and demoralizing collapse of an inflated industry. Widespread hardships ensued and costly adjustments were forced at great sacrifices.

The entire economic and social structure of the West was affected by the financial losses suffered by the livestock industry. Even more serious was the effect of the entire situation on the basic resource—the range.

With the decline in prices, livestock on the range, already overutilized on the strength of war and defense needs, were not marketed. Drought occurred in several sections. Less supplemental feed was used. The combined results were that throughout the West ranges were even more heavily grazed. As rapidly as possible efforts were made to halt or correct the difficulties but over huge areas the damage was ruinous. No magic wand, no rain, no increase in market price of livestock could restore grass or soil to land where destruction was all but complete. The consequence was, and is to this day, that from the time of World War I the range resource has not served as completely as it should in meeting the needs of the country.

[5] U. S. Dept. Agric., Bur. Agric. Econ., Agricultural Outlook Charts, 1940.

Following the close of World War I and the following economic depression, the livestock industry entered a period of reconstruction much as it had done after the earlier set-back in the 1880's. Recovery was steady, and although the range resource damaged during the war period did not change as readily as markets, the trend was generally forward. The sheep raising industry entered a particularly favorable cycle and, in general, an upward swing prevailed.

Then history repeated itself when the "bubble broke" in 1929. Livestock prices started downward and in the face of a falling market, surplus animals were held on the range. Demands for forage increased and a situation similar to the early 1920's began to develop. This time, however, the difficulties were accentuated and intensified by the most devastating and serious sequence of drought years ever recorded in the West. Forage was not available and prevailing livestock prices wouldn't meet costs of production. Operators heretofore prosperous were desperate. Some relief was absolutely imperative.

Public Interest in Privately Owned Range Lands.—Coincidental with these developments affecting the industry there had been a change in national thought which held that the public has an interest in the range resource irrespective of ownership and that it is in the public interest to assist in alleviating economic distress from the standpoint of general welfare. The livestock industry was urgently in need of the aid forthcoming from this philosophy. Various schemes for relief were extended by the public to the industry, ranging from actual purchase of surplus livestock in stricken areas in 1934 to the extent of some $100,000,000 to payments for certain conservation practices on range land in general.

Present Range Conditions

Through various public aids and the determination of the industry itself, the last depression in the range livestock industry was weathered. Following 1935 there was a period of lighter stocking of some ranges, especially in the Plains. There has been some improvement in management, and conservation efforts have been intensified and extended. Weather conditions in large areas in the range States have been unusually favorable during recent years, and the forage has been improving.

Now there are indications that the distress of the twenties and the thirties may be repeated. On January 1, 1942, the 17 western States were estimated to have on farms and ranges 32,755,000 cattle and 41,499,000 sheep.[6] It is doubtful whether the farms

[6] U. S. Dept. of Agriculture, Agricultural Marketing Service—Release of February 18, 1942.

and ranges can carry these numbers satisfactorily, even with the favorable weather conditions of the last few years. A severe drought would again result in serious overgrazing, deterioration of the range, heavy liquidation of stock, and widespread distress in the western range area.

The Future of the Western Range

The preceding discussion has indicated briefly the character of the Western Range, its history and present status. The next logical step is to contemplate the future of the resource in a way which will provide a background for a program of public works activities and adjustments.

The present western economy has been built and maintained to a large degree on the range and its multiple values as a foundation. Forage and water, and, to some extent wildlife, recreation, and other miscellaneous products of range land have all contributed to the economic and social development which has occurred.

An important consideration in the future of the range is its place and significance in western agriculture in general. Except in areas producing specialized crops such as fruits, nuts, vegetables, cotton, and wheat, the range plays a vital part in agricultural endeavor of the entire West. Everywhere the farm and range are interdependent and intimately linked one to the other. The farm produces the food to maintain the livestock when range is not usable and range provides the forage to relieve the farm during its period of production. Distance of many western farms from markets precludes other disposal of bulky products such as hay except to livestock. This system of complementary use is essential to optimum utilization of all resources, without which the importance of the West in the agricultural economy of the Nation would be relatively minor. Complete and proper care of the range is necessary to maintain this system of agriculture which is operating so effectively at the present time, but yet has promise of greater economic returns.

With reference to the range and agriculture the practice of finishing livestock for market deserves special mention. Over a large portion of the irrigated West and throughout the Midwest the practice has developed to buy feeder lambs or steers from the range, fatten them by feeding hay, grain, and farm byproducts, and then place them on the market. Other animals are sold as stockers to midwestern farms for growing on pastures before finishing for market. By these practices the farmer and range livestock producer supplement each other and both are able to profit accordingly. The result is that incomes are increased for both operators, and an interdependent, stable, and desirable rural economy is maintained.

Restoration of the Range.—At the present time, one all-important fact is evident; namely, that the range must be restored to and maintained at its optimum productive capacity within climatic limitations, so that it will best serve the West and the Nation.

The fact that the Western Range occupies nearly 40 percent of the total area of continental United States, that its various uses for forage, water, wildlife, recreation, and timber are so vital, and that the use of the range is so integrated with the social and economic welfare of the West, means that the resource has tremendous significance in the economy of the Nation. It means further, that any plans, programs, or procedures affecting the Western Range must be considered and evaluated with a broad national outlook. It means that populations far removed from the range itself have a close and real interest in the condition of the resource. And above all, it means that every possible local, State, and national action should be taken to place the resource in acceptable condition and maintain it there.

Without question restoration of the grazing capacity of the range resource to approach its original figure can be achieved, although in parts it may take a long time. Participation by both public and private interests is essential. The reason for private participation is obvious; the income, livelihood, and personal security of individuals are involved directly. The reasons for public participation are less direct but no less real—the range must provide its maximum contribution to the national economy and be properly integrated with other agriculture and other national interests. Therefore, public interest in the possible future of the resource must be strong.

The accomplishment of any effective program of public works to improve the western range requires not only carefully planned expenditure of Federal funds but also certain adjustments, particularly on privately owned land. These adjustments involve range use, ownership, planning, and in certain instances revision of laws. These adjustments should be made insofar as possible prior to or concurrent with any extensive works program. Without these adjustments the works program will be expensive, inadequate, and ineffective as compared to what might be done if they were made. Recommendations for the major adjustments required to facilitate the works program are presented in the following discussion.

Range use.—The western range livestock production, like many other enterprises, has developed without plan or schedule. This is a perfectly normal and not entirely undesirable circumstance, but it is evident that mistakes have been made. Perhaps the most serious of these, or at least the most important from the stand-

point of the future, has been to overstock the range with its attendant depletion of the basic resource. As a first step, therefore, in any program for the future, overstocking should be overcome where it prevails.

Therefore, before real value can be obtained from any extensive program of public works on the range, numbers of livestock on overpopulated ranges must be reduced to a point approximating actual grazing capacity. To accomplish this reduction all possible opportunities must be taken and in some instances temporary hardships to individuals and communities may be sustained. In general, reduction in numbers of livestock to grazing capacity, if carefully planned and executed, will cause far less immediate financial loss than appears at first thought and in the long run such adjustment will certainly be profitable. Public works developments which facilitate better utilization of forage may in part alleviate the amount of reduction necessary.

Since proper stocking and proper management are basic to any works program designed to improve range conditions for livestock production, watershed protection, and individual community welfare, it may be advisable, as part of a broad public program for the Government to assist, in certain instances, in liquidating livestock, ranch properties, or both. Purchase of livestock or range properties by the Federal Government is not an untried procedure. As noted before, during the drought of 1934 the Federal Government spent more than 100 million dollars in purchasing drought-stricken livestock throughout the West in order to prevent devastating losses to the stockmen and the communities concerned. More recently the Federal Government, in its land use program, has been purchasing lands submarginal for farming and restoring them to suitable range condition.

When livestock numbers are under satisfactory control, steps can be taken safely to institute a program of restoration involving both adjustments in use and public works. On federally controlled land an adequate public works effort to bring about range improvement can be applied any time adequate control of livestock numbers is reached. On privately owned land the situation is somewhat more complicated, but through the medium of various Federal agencies, soil conservation districts, and grazing associations, it should be possible to obtain satisfactory control of stocking and to carry out any work of public value irrespective of land ownership.

Ownership.—Because of a complex land pattern and other circumstances there are some serious range ownership and control problems which may be met as a prerequisite to or part of a public works program, by shifts of private land in critical areas to public ownership.

The reasons for this recommended shift in ownership are many. First of all in importance is serious watershed damage on many privately owned lands which is damaging or endangering other private and public interests. Second, is the serious doubt that private ownership can be maintained on a profitable basis and still permit conservation of the range resources on land of very low intrinsic value, or involved in such a complex ownership pattern that economic units cannot be developed. Under such conditions, private enterprise tends to exploit the resources in order to meet fixed charges. This practice results in liquidation of assets, devastation, ultimate break-down of the enterprise, and loss to the community and Nation. For lands where several uses are important to the general interest, public ownership is frequently most effective for safeguarding and developing these uses.

Range and ranch organization.—One of the greatest obstacles in the way of a program to improve the range involves the organization of ranch enterprises. A large number of livestock enterprises are organized on a "shoestring" basis and for that reason are economically unsound for furnishing an acceptable standard of living. Operations of this type cannot easily be adapted to a flexible program of conservation, and consequently efforts expended by the public with these units to benefit the resource will fail. In the light of these facts the public should make a supreme effort through educational processes, long-time, low-interest credits, and coordination of operations on public and privately owned lands, to encourage organization of family-sized operating units on a sound economic basis.

As a special phase of organization the need for a more equitable balance between range, improved pastures, and feed reserves should be evolved. In several areas, particularly in mountain valleys, hay and other feed is being produced in excess of the amount needed for livestock on adjacent ranges. Transportation costs will not permit shipping this feed and adjoining ranges will not support enough livestock to utilize it fully. This results in an unbalanced and unprofitable agriculture which eventually leads to a practice of grazing more animals than the adjacent range can normally support. The adjustment needed in this respect in many instances is conversion of crop-producing land to improved pastures and transfer of livestock from the range to these pastures.

Elsewhere in the West there are locations where the range is being abused because not enough supplemental feed is being produced. In some cases concentrated supplements are being fed to avoid ranch and range adjustments that are inevitable. And so on—circumstance after circumstance can be cited to indicate that in the range program for the future it will be necessary

to bring about adjustments in organization. Education, persuasion, assistance, and other public measures should be employed to aid and influence operators in this direction. Without these adjustments public works on large areas of range land will be seriously ineffective.

Legislation.—Adjustments needed in legislation over the entire range country are many and varied and to attempt detailed suggestions would be entirely impracticable. A few general revisions that apply rather widely, however, should be considered in the light of any program for the future designed to improve range conditions and outline effective public works. Inequitable taxation, for example, is a problem over the range area in general, and existing systems often encourage exploitation rather than optimum use of the forage resource. Range land assessments for tax purposes should be based on the productivity of the land when carrying the livestock which it will support over a long period of time without injury to the land, rather than on its productivity during unusually favorable periods.

Certainly there should be new legislation which would permit rural zoning based on careful land classification. Only by this procedure can the dangers of unwise land use be avoided and benefits of any public efforts be distributed accordingly. More suitable legislation must be perfected to handle tax delinquent range lands, in order to check deterioration and assure sustained production of forage and livestock. Consideration should be given to the adequacy of the present public credit system, and possibilities and needs for suitable legislative control of livestock production should be investigated.

There should be extension of legislation, permitting and encouraging organization of locally governed administrative units, relating to integrated farm, ranch, and range areas. Soil conservation districts, or cooperative grazing associations such as those now in operation in Montana, are examples of such units. Participation of stockmen in range matters has proved successful also in administration of national forests and grazing districts.

In respect to the legislative action needed as a background for a broad program of public works, the more or less recently enacted measures are of interest as supplementing older regulatory laws such as were applicable to Indian reservations and national forests with their provision for cooperative administration of intervening State and private lands. Within the last decade there have been enacted a great many important laws relating to range land conservation. The Taylor Grazing Act (48 Stat. 1269, as amended by 49 Stat. 1976 and 53 Stat. 1002), provides for administration of a large part of the public domain, leasing of isolated tracts, and provision for cooperative administration of intermingled state and private lands. The Pierce Act (52 Stat. 1033) permits lease and administration by the Federal Government of State, county, and private lands. The Soil Conservation and Domestic Allotment Act (49 Stat. 1148) provides payments for certain beneficial practices on privately owned land. The Federal Soil Conservation Act (49 Stat. 163) provides for assistance to organized range users and various State soil conservation districts laws assure cooperative regulation of use of private land. The Bankhead-Jones Act (50 Stat. 522) provides for removing submarginal lands from cultivation. The Pope-Jones Act (50 Stat. 869) provides needed assistance in the construction of water facilities in the arid West. All of these acts in full operation facilitate the application of public funds and works to range land. It appears that legislation of this type is indicative of additional laws which will be needed in order to permit application of a thoroughly adequate works program.

Research as Basis for Adequate Program and Plans.—A major contributing factor to the unwise use of the range in the past, to the present attendant ills, and to loss of misdirected improvement efforts, has been lack of knowledge—the absence of adequate experience or research facts and principles on which to base economical betterments. Full use of the range developed almost overnight by persons largely unfamiliar with western range conditions and generally accustomed to dealing with vegetation grown under more humid situations. Experience and the growing appreciation of range land values make it clear that correcting past mistakes and charting an effective course and program for the future must be founded on adequate facts.

Fortunately, it is not necessary to start from scratch. Bits of knowledge have been crystallized from experiences and from studies that have shaped into broad principles and practices of use. Here and there some excellent research has been done on biological and economic problems of the range, and, in general, sufficient data are at hand to delineate most problems and broad objectives of range use and conservation. But general guides are not sufficient for most effective planning of public works. The character of the range varies so greatly in different parts of the West, and climatic and other factors affecting growth and possibilities of use and improvement are so different that detailed guides are required for each of the several regions. This necessitates careful study in each area.

Action programs developed and carried forward under only general guides in the past often have involved high costs and resulted in many serious mistakes. Effective planning and the preparation of ade-

quate and detailed specifications for any work requires that research precede action insofar as possible, and public works as applied to the range resource should be no exception to this rule.

Range Lands of the East

The range of the eastern United States can be conveniently designated in two major divisions: the South, including the Ozarks, and the North and East, including the Upper Mississippi and Ohio River Valleys. In the latter division native forage producing lands are used chiefly as pasture adjuncts to farms rather than in range livestock production as known in the West. In the South the range has considerable regional significance, which is increasing as the need for a more balanced agricultural program becomes apparent.

The Southern Range

The South, as recognized in this report, extends from Virginia west to southern Missouri, south to the Gulf of Mexico, and east to the Atlantic Ocean. Within this area more than 200 million acres of uncultivated forage producing lands are available for grazing use. Most of this grazing land supports some forest growth, although a large and important area of nonforest marsh and other grassland, used extensively for range livestock production, occurs along the eastern seaboard, the Gulf coast, and inland in central and southern Florida.

In the early days of settlement relatively large numbers of livestock were produced on southern range lands, but as demands for cotton and tobacco developed, and the plantation system of one-crop agriculture grew, the production of livestock declined. This decline was universal except for local areas, particularly in Florida, until livestock production reached a point where it was purely incidental to other phases of agriculture. The Texas fever tick, until controlled, greatly hampered cattle production by causing poor development of animals, poor quality beef, and low value. Then gradually a change began to occur. Certain lands were found unadapted to one-crop agriculture, the number and quality of improved pastures increased, and farmers began diversification with livestock, using the native forage producing lands as pasture or open range adjuncts to their farming enterprise. The result has been that the amount of grazing on range land in the South has been constantly increasing in recent years and at present is important.

Present Status.—Generally speaking, commercial livestock production on southern range is confined almost entirely to cattle and in recent years both number and quality of this class of livestock has increased. It is estimated (1941) that about 4½ million cattle now use native forage-producing lands for at least a portion of the year. In terms of range and livestock production standards of the West, the grasslands of Florida support the principal large scale range livestock enterprises in the South. Probably 5 million or more hogs are also grazing range land but they are generally of low quality. Sheep production is not well adapted to much of the range land of the South and consequently is of relatively little importance except in the Ozarks and other limited areas. Locally the production of goats is important in the Ozarks and in parts of the Coastal Plain. Most of the range grazing use is by owners of only a few head of livestock and the area used by each individual owner is relatively small.

The range of the South is largely in private ownership, and most of it unfenced. There has been little effort to manage the livestock and less to manage the range. Recently, more attention has been given in the various States to fencing laws, which indirectly has brought about some livestock control and range management. Recent expansion of the national forest system has brought some additional areas under control.

One of the most important problems in animal production throughout the South has to do with parasites. In this respect the most important single step taken in reference to southern grazing has been the cattle-fever tick control campaign which has been carried on for the past 35 years by the U. S. Department of Agriculture, and which has now eradicated this restricting factor in all but a small area in Florida.

Throughout the South the general diet of the people is deficient in the very elements that beef, milk, and other livestock products can furnish. This deficiency is most critical in the undernourished, low-income families which have depended too much on cash crops and often have not had even a dairy cow. Cattle production offers an opportunity for the needed diversification in agriculture, for increased income, and for needed improvement of the diet.

The range of the South consists of four main regions: (1) Coastal Plain, (2) Piedmont, (3) Appalachian Highlands, and (4) Ozarks. Of these, the most important in cattle production is the Coastal Plain. This area includes the extensive longleaf pine type, the marsh grass type on the Atlantic and Gulf coasts, and grassland areas of Florida. The forage consists principally of native and a few introduced grasses. The marsh grass and a few other areas, when supplemented, may be grazed for much or all of the year rather satisfactorily. Generally, however, the palatability of the grasses is at a peak for about 90 days in the spring and early summer, after which the forage becomes less valuable as the season progresses. In the pine type, burning of accumulated dead grass during the winter is a

common practice in an effort to improve grazing. This often seriously damages timber production. Grazing, if properly adjusted, furnishes current revenue to the timberland owner while timber is being produced, reduces the fire hazard, and betters the condition of the heavy rural population.

The Piedmont is a somewhat larger area than the Coastal Plain but because of differences in forest types and possibly fire histories and other agricultural development, range grazing has been more limited. The lands most widely grazed in this area are the abandoned farm and cut-over tracts which have not been fully restocked with timber. Population demands are so great that all possible income must be looked for and accordingly, it may be well to dedicate certain areas of physically possible timber production to grazing for social and economic reasons. On productive forest lands restocking to the exclusion of grazing comes ordinarly in about 20 years and with it livestock use declines or may be eliminated entirely.

The forested areas of the Appalachian Highlands are not generally favorable for grazing, except for occasional "balds." Valleys are often developed as improved pastures and other forage-producing lands. As the land is placed under management for high quality timber production, the dense forest growth, the inadequate forage production and danger of damage to hardwood reproduction, soon eliminate commercial grazing. Livestock production under these circumstances is reduced to little more than subsistence of herds of two or three animals owned and grazed by subsistence farmers.

In the Ozarks, about 25 million acres of rough, broken forest land is used for grazing. For the most part the livestock—cattle, hogs, or goats—are owned by small operators on little more than a subsistence basis. Livestock have more or less free use of all forest lands and open glades and are rather generally overutilizing the resource. Purchase of land for national forest purposes, however, is bringing with it a degree of control on those areas. Under proper management, range grazing in this area should be a profitable adjunct to farming and timber growing enterprises and a vital factor in maintaining a reasonable standard of living for the dense rural population.

Future.—As indicated previously, there is great need in the South to increase the use of meat and livestock products. To do this will require better use of the range and more improved pastures and supplemental feed. To accomplish the former an intensive research and extension effort is needed. The second will, undoubtedly, be accomplished as the reduction in cotton production, increase in acreage of soil-conserving crops, and mounting difficulty with labor all combine to bring about an increase in pasture and other forage production.

Too much emphasis cannot be placed on the need for more improved pastures in the grazing industry of the South. These improved pastures are to southern range grazing what the crop and hay lands are to the western range livestock industry. Without adequate pasture and supplemental feed, the grazing industry is a makeshift arrangement on a simple subsistence basis. With better balance between range and other agricultural production, breeding and care of animals can be improved, more effective utilization of range forage can be made, animals can be maintained in good condition year-long, and the livestock business can be stabilized on a profitable basis.

Additional improved pastures in the South do not mean conversion of range to cultivated land. Instead it means the reverse—conversion of low value farm land to forage production. To establish and maintain these pastures will probably require considerable expenditure. In order to justify this cost the production of livestock must be intensive and efficient.

No matter how the situation is viewed it appears that livestock in the South will increase.[7] All factors considered, however, it does not seem that southern meat production will influence national markets greatly, at least for years to come, since any reasonable expected increase in meat production will be required to satisfy increased local needs and demands. With educational effort in nutritional needs and more beef and milk available on the farms and at reasonable prices in rural communities, the deficiency of meat and other livestock products in the southern diet should and could be reduced greatly.

Improvement in use of ranges, which needs to be preceded by research and extension efforts, and an expansion of farm pastures will result in better livestock, better use of range forage, and greater opportunities for increased returns to all individuals and communities concerned. These added opportunities for increasing income will be furthered by public works activities such as fencing, fire breaks, etc., on range land.

Northeastern "Ranges"

In contrast to ranges of the West and South, grazing of native forage producing lands in the northeastern portion of the country is confined almost entirely to intermingled abandoned cultivated fields, farm woods, mountain balds, and restricted areas of forest lands. Some 40 million acres of such lands are grazed.

[7] Any great increase in livestock production in the South would necessitate an increase in the size of farms.

Although such grazing does not form a major industry, it is quite important as a pasture adjunct to other farming enterprises in the social and economic welfare of the rural population where it occurs. Much land on which forage is produced would be practically non-income producing while waiting for the forest to reach commercial size if it were not for the grazing values. Income can be supplemented and a farming enterprise which might be otherwise unprofitable can be placed on an economically sound basis through restricted grazing in harmony with reproduction needs.

Portions of the northeastern section of the country used for such "range" grazing are the southern portion of the Central States, scrub and other forest land in the Lake States, and the bald hills of the Alleghenies and Adirondacks. In all sections, however, grazing is more or less incidental to other activities, including forestry.

Grazing of forest land by deer is more widespread and in many places more important than grazing by domestic livestock. This grazing use by wildlife must be given full consideration in any program outlining the future of northeastern "ranges."

Because the grazed area has predominant forest possibilities, livestock production will take a secondary position. Nonetheless it should not be omitted. It may specialize on the marginal areas and still be an important factor in the maintenance of many rural homes. Accordingly, attention should be given to measures needed to facilitate use of the land for effective grazing and to coordinate grazing and forestry satisfactorily. Where such grazing is locally important it certainly should be given full consideration.

Territorial Ranges

In each of the three major territorial possessions of the United States—Alaska, Hawaii, Puerto Rico—range land is of considerable importance locally. In Alaska about 200,000,000 acres are classed as potentially usable range land. This consists primarily of vast areas in northern and western Alaska having a favorable environment for many thousands of reindeer. Reindeer furnish a wide variety of products needed in day-to-day existence of the Alaskan native. The meat is used for food, the offal from butchering for dog food, the skins for winter clothing as well as for fine leather, and the animals to a limited extent for transportation. The reindeer industry thus means much to the social and economic welfare of the Eskimos. Cattle and sheep in relatively small numbers have been successfully raised under range conditions for a number of years in southwestern Alaska and on adjacent islands.

About one-third of the area or approximately 1,300,000 acres, of the Hawaiian Islands is used for grazing. Certain islands of the group produce high quality beef cattle on a scale resembling typical cattle ranches of the western United States. On these areas well-bred cattle use more or less open grass range and are handled much as they are on the mainland.

Of a total land area in Puerto Rico of about 2,100,000 acres, approximately 750,000 acres are usable for grazing. Puerto Rico has a population density of over 500 persons per square mile, with less than one-half acre of arable land per person. The diet of the people is very deficient in protein and meat is so expensive as to place it beyond the reach of the bulk of the population whose annual income is low.

In spite of the rather large percentage of range land in each of the Territories none of them produces enough livestock to satisfy the present needs of their population. Furthermore, it is believed that livestock production in the Territories will never be so developed that it will more than care for local populations. Notwithstanding, it is quite essential for several reasons that more and better meat be produced in the Territories and that a program of public works adequately provide for development of the range resource. The time allowed for this range conservation report has not permitted the assembling of detailed information on the present range situation or its desirable development.

2. OBJECTIVES OF A RANGE CONSERVATION PROGRAM

Stated in relation to the central aim of a national land-use policy, the broad objective of range conservation activities is to rehabilitate, develop, maintain, and manage the range resources of the nation in such a manner that "man may derive from the land, maximum employment, benefit, and satisfaction consistent with the permanent maintenance of land resources."[1]

Improper stocking generally, abetted by drought, unwise plowing, and fire have doubtless been the major causes of past deterioration on range lands. Rodents have also played a part locally. With deterioration of the plant cover, precipitation has had less hindrance to dissipation through run-off, and the more rapid the run-off, the greater the erosion of soil. The loss of the fertile top soil has made maintenance of the cover more difficult. Thus, a cycle of deterioration has been set in motion that has had far-reaching consequences in reduced forage production, less return from livestock, loss in production of the soil, damage from floods, and all the social and economic ills stemming from such conditions.

If the consequences of improper range use are to be avoided, it will be only because the entire Nation takes the situation in hand promptly, emphatically, and competently. There is no controversy as to ultimate objectives and there should be none as to immediate means of reaching them.

Restoration of the range as a whole to its former productivity would provide approximately twice the forage and this in turn would expand several-fold the opportunity for profitable production of livestock, for taking greater advantage of facilities for management, and for improving the standards of living of farmers and stockmen whose animals graze the range. Moreover, it would give far better watershed protection and afford vastly greater opportunities for wildlife production, recreation, and other services from the land.

Rehabilitation and development of the range lands and their subsequent proper use will not only insure the productivity of the lands for future generations, but will also provide many thousands of underfed, undernourished people with the necessary livestock products and thereby strengthen and build up the security of the vast rural population of the Nation.

[1] National Resources Planning Board. *Public Land Acquisition in a National Land-Use Program.* Part I: Rural Lands. 1940, Page 1.

Specific Range Conservation Objectives

Specifically, the objectives of a range conservation program include the following:

(1) To stop soil and forage depletion, to provide for soil building, and to produce as much forage or other suitable plant cover as possible on range lands.

(2) To use the range in such a manner as to provide sustained optimum production of livestock and livestock products, consistent with all other uses of the range, and integrated with crop and pasture production.

(3) To improve the land-ownership pattern and rectify land-use maladjustments.

(4) To prevent wastage of human resources and to insure economic and social security among those whose livelihood is dependent upon the use of the range lands.

Control of Range Depletion and Improvement of Soil and Cover

Range depletion, the loss of productive value from range land, is extremely widespread and due to a number of causes. The key to stopping the widespread soil and forage depletion and starting the improvement process generally on range lands, is the application of sound range management. Such management would provide for grazing the range with proper numbers and kinds of livestock during suitable seasons, effective handling and distribution of the livestock, application of suitable systems of grazing, and effective development of range facilities.

Public works activities have an important bearing on the attainment of the objective of control of range depletion and improvement of soil and forage cover.

Soil and Moisture Conservation.—Control of soil erosion is the first and most essential step in the direction of correct land utilization on a major part of the range land of the Nation. Without it, there can be no permanent range livestock industry.

Misuse or improper management of land results in the loss of fertile and productive topsoil. Continued action of wind and water on denuded or partially denuded slopes results in further losses and, unless checked, destruction of land and vegetative cover is accelerated. Practically all ranchers have seen the disastrous consequences of erosion. They have watched the odd-colored patches of soil appear one by one in their pastures as the rich topsoil washed away to bare the nonproductive subsoil strata. They have seen clear and sparkling streams grow muddy and sluggish with

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a load of rain-washed soil. They have watched the wind strip millions of tons of soil from the High Plains country and sweep it in a vast and ominous cloud eastward across the continent to the sea.

Over much of the range area, where the annual precipitation is low, farming is dependent largely upon flood or storage irrigation. Sedimentation from range lands into channels and storage reservoirs directly and indirectly affects farming activities through inundation, infertile overwash, bank cutting, and the loss of available water supply by decreased storage facilities and increased evaporation. Removal of soil from range watersheds thus not only results in destruction of valuable range land, but also through deposition of this soil in streams and reservoirs, threatens land and improvements below.

Soil and moisture conservation on range lands is attained primarily by maintaining as good a cover of vegetation as possible, and this comes from attention to proper grazing use.

The attached diagram emphasizes the complexity of the situation, the importance of united action with the watershed as the unit of treatment, and the necessity for close coordination between ranchers, farmers, conservationists, foresters, range men, agronomists, soil specialists, and engineers in attacking the problem.

The problem of soil erosion and forage depletion arises basically from man's failure or inability to adapt his use of the land to the physical limitations imposed by nature. Practical conservation becomes a matter of achieving the maximum degree of harmony between land adaptability and land use in the light of climatic, economic, and social exigencies.

Range Improvements.—For affording the necessary control, facilitating distribution of livestock, and otherwise aiding proper grazing use, the installation of certain types of range improvements offers great potentialities. Such improvements as fences and water developments, for example, facilitate the use of the range under a flexible type of management that permits adaptation of the intensity of grazing to the amount of forage produced each year. Grazing on fenced portions of the range can be deferred to afford the palatable plants full opportunity to mature before being grazed. Fenced portions can also be held free from grazing for the establishment of forage reserves as an insurance against low forage production in unfavorable years.

Revegetation.—Most of the range area has sufficient forage and other plants growing on it and sufficiently good soil and moisture so that it can be improved through range management alone. Over large areas, however, the stand of desirable forage plants is now so thin, and the loss of fertile topsoil has been so great, that it will take from 20 to 50 years of improved management, or even longer, for the range to recover its former productivity under natural processes. Such conditions require reseeding or other forms of planting if a satisfactory stand of forage is to be established. This is not a simple process and usually requires from 2 to 3 years after seeding before the stand is fully established.

Fire Control.—An important factor in deterioration and depletion of western range lands has been fire, especially in California, in the sagebrush plains and in the foothills of the Intermountain country. Also, fires have burned widely in the South. A great many accidental fires result from high inflammability of vegetation during the dry summer, and in a few instances fires are set by stockmen in an effort to open up dense brush stands and in the hope that the low-value vegetation present will be replaced by plants of greater value. The net result has been that repeated burns on millions of acres of range lands have often changed the whole character of the vegetation, usually greatly reduced its forage value, exposed the soil to devastating erosion, intensified floods, and aided in aggravating locally the uneconomic ills which have beset the livestock industry generally.

Control of Range Destroying Rodents.—Damage by rodents on lands outside of strictly farming areas has been estimated to cause an annual loss of $150,000,000. This damage arises from forage consumed, seed destroyed, plants killed or covered up by mounds of earth, and erosion losses due to disturbance of soil. Streambank and gully erosion is increased by burrows which open the way for quick cutting by running water. Also the action of some species of rodents in burrowing into streambanks, earthern reservoirs and irrigation canals adjacent to or crossing range lands has caused breaks in these structures with resulting damage to land, irrigation works and farm improvements amounting to thousands of dollars.

Generally the impact of rodent damage is greatest upon land that is in depleted condition although consumption of forage by rodents upon land in good condition is a waste and an economic loss that ought not to be tolerated when it is possible to control these animals.

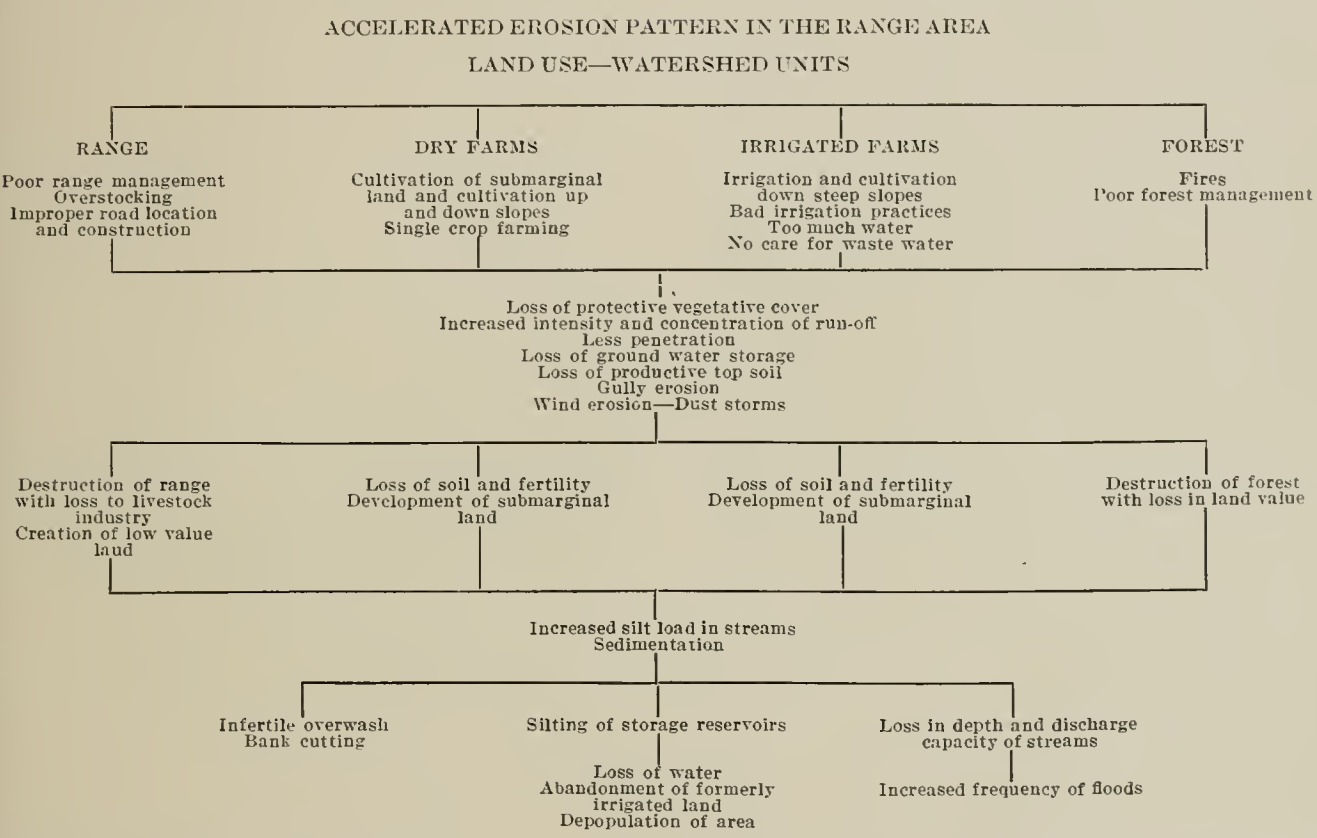
Maximum Production of Forage.—Range lands generally are producing far below their potentialities in uses and services. In general, there has been a tremendous decrease in the quality and quantity of the forage and gradual deterioration of the basic resource, the soil itself. Estimates prepared for western ranges [2]

[2] The Western Range, U. S. Sen. Doc. 199. 1936.

indicate that it takes one-fifth greater acreage of tall grass to feed a cow now than it did when the range was first used, twice as much on short grass range, and more than three times as much on sagebrush-grass range.

It is not enough simply to bring about improvement in the native vegetative cover. The objective should be to have each area producing the full amount of forage of which it is capable, and at the same time providing the maximum protection to the soil and watersheds.

Numerous phases of public-works activities relate to the attainment of maximum production of forage. All of the activities previously mentioned have an important bearing. In addition, noxious-plant control removes undesirable plants and affords the opportunity for the more valuable species to attain full development. Range surveys and plans furnish the basic information and programs for management adjustments necessary to bring about the desired forage production.



An Integrated Program for Use of Range Lands

The use of the range-land resource is multiple in scope. The complexity of interwoven livestock, wildlife, watershed, and other uses and services necessitates that any program that accomplishes proper range conservation consider all of the uses and services in their relative importance and correlate them in an over-all planned program.

Optimum Livestock Production.—The optimum production of livestock and livestock products should be considered as that quantity and quality of production that can be sustained through the years without impairing the range resource, and that permits improvement where deterioration prevails. Numerous experimental and practical demonstrations have shown that optimum production can be most easily attained on areas where the forage and soil resources are in relatively good condition. The optimum production of livestock and livestock products is accordingly closely related and interwoven with the necessity of improving and maintaining the range forage resources.

The necessity for wide recognition of the benefits that can be derived from sustained forage yield and maintained soil productivity is the crux of the problem. Many demonstrations of such benefits are available. These benefits may be in the form of reduced feeding costs and lower cost of livestock production. For example, in Montana it has been found that for cattle, the total feed costs on heavily grazed ranges were approximately 111 percent of the total feed costs per animal unit on moderately grazed ranges. Other experimental studies show that when the number of cattle kept on a given amount of feed is reduced one-third, the amount of feed used per pound of calf produced is reduced two-thirds.

Desirable Wildlife Population.—Wildlife is one of the natural products of the range. Deterioration of the habitat through range depletion has destroyed both food supplies and cover for land animals and birds, and siltation of streams in range areas has reduced the food supply for fish and waterfowl.

It is essential that a balance be maintained between game populations and the forage available for game use. Overstocking a range with game can produce the same detrimental effects as overstocking with livestock.

Maintenance of Recreational Values.—The depletion of most range land areas is further reflected in impaired recreational values. Range lands, as well as others, possessing qualities sought by outdoor recreationists have acquired economic values which often exceed the values for other services. People, as a rule, do not pay directly for the privilege of enjoying scenic charm or other recreational values, but they do pay indirectly through the purchase of commodities and services for which there otherwise would be no local market.

Forest and Other Resource Values.—Among the important resources values on nearly 350 million acres of forest range are timber, fuel, fence posts, and other wood products, particularly on those areas supporting commercial forests. Overgrazing has often been detrimental to timber production. Range lands also furnish a number of other miscellaneous resources such as medicinal, fiber, and other plants of economic importance that are often helpful in supplementing incomes of rural people in certain localities. If the management of range land does not take these resources into account, damage may be done that affects the local income possibilities of these rural people.

Many public works activities relate directly or indirectly to optimum use of the range in the production of livestock, consistent with other uses and services of the land. Again of especial importance are fences, water developments, and a great number of miscellaneous range improvements. Also again surveys and plans furnish the basis for programming use in a thoroughly integrated manner as it relates to the different resource values of the range lands themselves and most effective use of such land in coordination with forage and feed production on cultivated lands on farms and ranches.

Correlation of Range Use with Use of Other Lands.—The growing of domestic livestock on open ranges, its production on improved pastures, and the production of farm products on cultivated lands need much closer correlation. Grazing, which in the beginning was largely an independent and pastoral enterprise, and which after a long, slow start expanded more rapidly than crop agriculture, has now become vitally dependent upon crop production. Economic production of crops on many farms is likewise dependent on availability of range lands. Establishment of a proper balance between livestock production and crop production is an integral part of the over-all agricultural program.

Land Ownership Adjustment

Settlement of the West and the transfer of land from Government to private ownership was accomplished without the benefit of a policy adapted to range conditions. Lands were neither classified to promote their highest use nor parceled into units of suitable size for carrying on the activity most likely to succeed when matched against the differences in soil, in climate, in vegetation, in markets, transportation, and the numerous factors that make agricultural operations succeed or fail. Most of the lands occupied were homesteaded under the basic Homestead Act of 1862 which permitted the homesteader to receive 160 acres of land from the Government, or under the Enlarged Homestead Act of 1909, or the Stock Raising Homestead Act of 1916, which permitted the settler to acquire 320 and 640 acres respectively.

In but few parts of the western range territory are even 640 acres sufficient for a suitable livestock ranching unit unless there is opportunity to practice irrigation farming in conjunction with these lands. Many small homesteads were doomed to failure and often were not patented until after several settlers had tried their hand at making a go on the land. Great numbers of homesteads were abandoned after a few years or sold to larger, more permanent livestock operators who had usually grazed the range before the settlers came and who suffered disruption of their operations during the settlement period.

The heavy influx of settlement in the Great Plains and other portions of the western range occurred during a cycle of favorable precipitation and high prices for grain. Crops were planted in the newly broken, virgin soil, and produced remarkable yields. As large, quick returns were possible from raising grain, many acres smooth enough to plow were put in cultivation. Settlers seeking out and competing for every acre of land in the West that might produce a crop of grain cultivated much land valuable chiefly for grazing purposes and submarginal in character for grain production. In turn, this homesteading of range land upset established livestock ranches, created an unhealthy competition for the remaining remnants of range land, raised land prices to false levels, and prevented establishment of ranch and farm units upon a sound economic basis. Then the weather changed from a wet to a dry cycle and dry-land farming as an agricultural practice proved unstable on much of the area. Foreclosures, abandonment, and forfeiture for taxes left a tangle of land ownership too intricate for private initiative alone

to unravel. Fully effective use of the range resource, therefore, cannot be achieved without a comprehensive program of land ownership adjustment, aimed chiefly at consolidating the ownership pattern and establishing range and agricultural operating units of efficient size.

Preventing Human Wastage

The pioneer in the range territory suffered many hardships. More recent settlers and stockmen also have had to bear hardships resulting from misused and underdeveloped resources, uneconomic production, and inadequate employment opportunities. While the problem of overcoming human wastage and giving security to rural people concerned with the use of range land will require numerous adjustments and social and economic developments, public works activities offer many possibilities in this connection.

Insofar as public works can be made to improve the productive plant and the opportunity for better use of the resource values, that in itself, will be of benefit to range users. In periods of depression the economic security of large numbers of ranchers may be seriously affected. The ones who will be most concerned are the small operators. The development of an extensive program of public works at that time would offer employment opportunities and may make it possible for many of these people to weather the storm.

Public and Private Responsibility for Action

In the final analysis, the success of a long-time plan for essential readjustments in range land economy will depend on local action as well as on Federal and State action. The Federal agencies may take the necessary action on their own lands, and may advise, assist, and coordinate activities on other lands; State agencies may administer permissive or mandatory legislation, but in the end all agencies—Federal, State. local, and private—must cooperate in stimulating the adoption of proven methods of management if the potentiality of the range is to be approached. There is a definite responsibility on the part of public agencies to provide the facilities essential for proper use of the public ranges, and to assist in the installation of range conservation facilities on privately owned ranges where it is in the public interest to do so. Primarily, however, the responsibility for using the range resource of both public and private ranges in a prudent, forward-looking manner rests upon the range users. Unless and until this responsibility is recognized, and positive steps taken to meet it, Federal and State assistance will be only partially effective.

3. PUBLIC WORKS NECESSARY FOR RANGE CONSERVATION

Rehabilitation and development of the Nation's range resource to a substantial degree are public responsibilities, and offer great opportunities for wise public investment. There follows an attempt to visualize the nature and scope of a possible long-term program of public works, designed to arrest damage to range lands and restore their productivity, and to achieve optimum use of the range.

Arresting Damage and Restoring Productivity

The major public works which relate to arresting deterioration and improving or restoring productivity are fencing for control of livestock, soil and moisture conservation, fire control, rodent control, and revegetation. Some other works, such as water development, relate to these purposes indirectly or in local situations directly but more logically serve to make optimum use of the range and are discussed later.

Fences for Control of Livestock

Control of livestock is basic to the kind of management which will arrest range damage and start the rehabilitation process. If too many livestock are grazed on an area the palatable forage plants lose their vigor and if overstocking continues and is sufficiently severe, the stand gives way, gradually at first and with increasing rapidity as deterioration progresses. Accordingly, among the primary requirements of management are to stock the range with suitable numbers of livestock during desirable seasons, to avoid concentration of livestock, and otherwise to control numbers and distribution of animals so that the forage is not damaged and has a chance to recover if it is in a deteriorated condition.

Fences provide an economical means for controlling numbers of cattle or sheep grazed without herding in range pastures, for limiting the degree of grazing, and for confining animals to that part of the range desired. Other important uses of fences include dividing the range for deferred, rotation, or other special systems of grazing; segregation of different kinds and classes of livestock for livestock-management purposes; protection of animals, especially cattle, from poisonous plants; and provision of pastures for livestock during round-ups, for saddle horses and other work stock, and for special and emergency situations. Such uses encourage better management and range restoration. Certain areas, too, that are particularly important for watershed, timber production, wildlife, or recreational purposes, may require fencing to eliminate livestock grazing.

Stockmen for many reasons want their livestock separated from those of others. This is true whether their animals are grazing on their own land or on public lands. Where the livestock operations are sufficiently large individual ranges on public lands are desirable since they encourage better management. Great numbers of farmers and stockmen, however, own such small numbers of animals that use of public-allotment areas and fenced private ranges is advantageous to them and to the range.

In the West the amount of fencing has been governed in large part by land ownership. Most of the Great Plains is privately owned. There, many stockmen have fenced their own lands or cooperated with their neighbors in building fences between their lands. The large number of abandoned farms which have resulted from the collapse of the overexpansion in wheat production and the large amount of nonresident ownership in the Plains, however, has left a vast area, made up of small units now unfenced and upon which grazing is usually uncontrolled. Such lands have ordinarily become a "no man's land" and present some of the most depleted conditions in the Plains area.

The size of the outfit, the grazing capacity of the land, the character of the livestock enterprise, the desire to apply management, and other related factors will determine the amount of fencing that will be justified. Generally, however, far more fences than are now available are needed on private lands to give desirable control of livestock and for most effective production and protection of public interests. This is especially true of the smaller outfits which are struggling to make a living and which because of inability to divide up the parts of their range are unable to obtain optimum production conditions. It is estimated that 955 thousand miles of new fencing are needed on western private, State, and county lands in order to safeguard the resource, protect other public interests, and make possible more profitable production.

On western public ranges many fences were built by stockmen to facilitate management or to control land or livestock. More recently the Federal Government has been constructing most of the fences on lands under its control, although stockmen still cooperate in furnishing materials or labor. The need for control and management fences on Federally controlled ranges, however, is still enormous. It is estimated that 160 thousand miles of fences are needed.

In the South the amount of fencing varies greatly with localities. Primarily, fences have been built to protect cultivated fields from range livestock. In a number of States, however, fence laws for the State as a whole, or for districts within the State, have been enacted which make it necessary, when enforced, for the owner of livestock to confine his animals within a fence. Most range livestock, however, still run loose. It is estimated that some 2 thousand miles of fencing are needed on Federal lands and 100 thousand miles on private lands, to give more effective control of livestock and to assure better use. In the Ozark area fences are badly needed for control to overcome damage. The bulk of the fences in other parts of the South, however, will be primarily for making optimum use of the forage.

Most of the "range" land in the northeastern portions of the country is already fenced, although some 4 thousand miles of fencing are needed to enclose Federal lands and to safeguard timber production and watershed values on areas which should not be grazed. It is estimated that an additional ten thousand miles of fences will be needed on privately owned range lands to improve their use and safeguard other interests.

Soil and Moisture Conservation

Control of erosion at its source, or as close to its source as possible under existing conditions, should be the primary purpose of all structural works for soil and moisture conservation.

The critical condition of soil erosion and the destructive concentrations of precipitation into surface run-off have been brought about by a disregard of the dictates of nature. Consequently, a logical approach to the problem of rehabilitation and stabilization is through a return to the natural pattern of conservation. Treatment measures, therefore, should employ a minimum departure from natural processes and priority should be accorded to work of vegetative character.

Maintenance of a protective vegetative cover is prerequisite to erosion control on range land. Under certain critical conditions of erosion and vegetative cover, where the return to erosion stability by vegetative measures is too uncertain or too slow, supplementary treatment through mechanical or structural measures has an important function in the program of soil and water conservation. Because of the close tie between the various types of treatment, a working knowledge of all practices involved is necessary.

Classification according to benefits.—Necessary control measures may, for the purpose of justification, be classified under three general headings, namely: (1) Those which primarily benefit the land under treatment; (2) those which primarily benefit other land and improvements; and (3) those which benefit equally land under treatment and other land and improvements. Structural measures which fall in the first class are largely those used to supplement vegetative measures and include fences (boundary, division, and enclosure), stock-water development (tanks, wells, and springs), terracing, reseeding, and water retardation or water spreading structures (contour furrows, dikes, diversion dams, and spreaders) when the intensity is such as to benefit primarily the land under treatment.

Structural measures which fall within the second class include detention dams, soil-saving dams, and major water-spreading systems when used primarily to protect other lands, and improvements from cutting, sedimentation, or inundation.

Structural measures which fall within the third class include: (a) many of those listed in the first class when used more intensively in order to protect other land and improvements in addition to the land under treatment; (b) stock tanks, soil-saving dams, and detention dams when used to stabilize land under treatment as well as to protect other land and improvements; (c) bank-protection structures such as levees, revetments, stream bottom fencing, tetrahedrons, etc.

Justifiable Intensity of Structural Treatment.—The question of justifiable intensity of structural treatment involves the following factors, some of which can be determined only after further experimentation:

1. Land classification according to erosional activity, production potential, and use.
2. General and specific objectives of treatment.
3. Results which may be expected, using various types and intensities of treatment.
4. Costs of various types and intensities and their relation to immediate as well as ultimate benefits.

Fire Control

The public-works program for fire control included in this statement relates to nonforest range lands only. Control activities to protect forest values, covered in the section entitled "Public Works and Forest Lands," also give protection to the undergrowth in the forest, and to the intermingled untimbered land that makes up the grazing resource in forest areas.

In the South forest fire control activities will provide for most of the needs on the extensive area of range land. There are, however, certain needs on untimbered range lands and on areas where forest production is so low that fire protection for forest values would not be justified. At the present time, however, many of such lands are being given fire protection by the forest fire protective organizations of the States, to protect adjacent forest lands, and to furnish a demonstration in fire control to farmers and stockmen grazing forest lands. Facilities to aid fire control on the nonforest range land would materially strengthen their conservation.

On western ranges, in the old days, grass fires were a serious menace. They are again becoming an increas-

ing hazard as conservation is improving the stand of grass.

In general, the need for public works for fire control on "range" lands in the northeastern portion of the country is very minor because of the limited area that is grazed and the reduction in fire hazard resulting from grazing use. There is not the same tendency, as in the South, to burn the woods. Therefore, forest-fire protection in this portion of the country will take care of nearly all fire-control needs on native forage-producing lands.

Speed of attack is the essence of fire control. Fire travels rapidly in good grassland and brush. A whole countryside may burn in an hour or two. Once a fire starts it increases progressively in size as long as fuel is in its path and weather conditions are favorable to combustion. Accordingly, the suppression task becomes progressively more difficult, more costly, and less certain the longer the fire burns. Moreover, large fires occasionally burn livestock, ranch improvements, and products of farm and ranch. Such tangible losses that upset ranch operation emphasize the necessity for facilities which make possible prompt attention to fires.

An important link in speed of attack is prompt detection of fires. In general, and especially in rolling or rough topography, this necessitates lookout towers or other fire-control observation points. The number of lookout towers and their location will largely be determined by such important factors as the fire hazard, the character of the vegetation, the rapidity of spread of fire, and other similar factors. A communication system, such as telephone lines or radio, for the reporting of fire, and roads and trails to facilitate the movement of men and equipment, are essential parts of the fire-control organization.

Firebreaks serve as one of the major controls for range fires. Their purpose primarily is to protect areas from known risks, as along highways and railroads, and to break large areas into smaller tracts to facilitate control and afford places from which backfires may be set when conditions are such as to demand that method of suppression. The character of firebreaks will depend chiefly upon the character of the vegetation, its density, and fire danger. In most grasslands plowing a number of parallel furrows from a rod to several rods apart and burning the material between the furrows in the forepart of the season forms an effective barrier to the spread of fire. In dense brush more adequate firebreaks are essential.

Of primary importance in all parts of the range country is education of the people to the menace of fires, to overcome the tendency of farmers and stockmen to start range fires and to emphasize the importance of public cooperation in preventing and suppressing them.

Rodent Control

In every section of the country one or more rodent species can be found. Prairie dogs, rabbits, ground squirrels, kangaroo rats, and pocket gophers are the principal range-destroying and forage-consuming rodents. These animals are increasing in number as man removes their natural enemies. The rodent-control program is designed to limit the number of rodents only to such an extent that a natural balance may be established.

A program of rodent control is especially needed where small but highly productive bodies of farm land are intermingled with large tracts of rodent-infested range lands. These larger tracts of range land provide excellent breeding grounds for rodents that reinfest adjacent agricultural land if not controlled. It is not practical for the farmer whose land is surrounded by large areas of public and private land successfully to meet the rodent-control problem with his own resources.

Cooperative action by all landowners and managers is necessary if the drain upon the range and related agricultural lands by rodents is to be reduced and the burden of control equalized.

The drain upon the forage resources from rodents not only varies greatly but may be of considerable magnitude. For example, it has been estimated in the Southwest that only 15 antelope jackrabbits would be required to eat as much valuable range forage as one sheep and that 30 Arizona jackrabbits would eat as much as one sheep. In the same region kangaroo rats, which draw heavily on the yearly seed supply of grasses, have in drought years eaten the crowns of palatable perennial grasses and left local range areas practically barren.

In general range lands in depleted condition seem to harbor more pocket gophers than do range lands in good condition, for the reason that depleted range often supports a larger quantity of plants forming fleshy roots and bulbs than does range supporting a good stand of grasses, thus supplying more food relished by this species.

Control of rodents prior to or in conjunction with other improvement efforts is advisable. It is unwise for example, to broadcast seed for revegetation if the rodent population is so large that the seed will be gathered or the young plants consumed by these pests. In quantity the need for rodent control is estimated to cover 73 million acres on Federally controlled ranges and 100 million acres on private, State, and county land in the West; 1.5 million acres on Federal and 10 million acres on private lands in the South; and 33,250 acres on Federal land in the Northeast.

Revegetation

Revegetation, as considered here, relates to seeding or planting of vegetation by man rather than natural re-

vegetation. It has as its most important purpose the stopping of soil losses from eroding and deteriorated ranges. It is also the very essence of restoring worthwhile forage production within a reasonable period on millions of acres of plowed and depleted range which in their present condition are a drag on profitable livestock production, if not actually submarginal for grazing use. It offers opportunity, at least in certain localities, for producing earlier and greater quantities of forage in the spring than is now available from the native range plants. In other localities it makes available more nutritious forage. On lands from which noxious plants are removed, revegetation to desirable forage plants may prevent reestablishment of the noxious plants. Many other important and desirable reasons for revegetation might be listed, such as provision of forage for game and cover and food for birds and other wildlife, and improvements of stream channels for food and better habitat conditions for fish.

In considering reseeding in the West it must be remembered that the average annual rainfall is only about one-third of that of the East, that the great bulk of range lands receive less than an average of 20 inches a year, that far more than half receives between 10 and 15 inches annually, and a considerable portion receives less than 10 inches. Moreover, rainfall is sufficiently below average either for the year as a whole or seasonally every few years or groups of years to cause conditions considered as drought. Evaporation is generally high and hot winds may further accentuate unfavorable growing conditions. To meet such adverse conditions plants must be drought-resistant or drought-enduring and at the same time be able to reestablish themselves under grazing and maintain their stand long enough to repay the costs of seeding or planting.

Seed for range revegetation should be available so that plantings may be made when conditions are appropriate. Not all species can be obtained commercially. Stocks of seed of locally important plants can be obtained by gathering seed on the range or they and other desirable plants can be grown in seed nurseries.

While research, observation, and practical seeding trials are continually expanding the chances for success, the area which now can be considered as suitable for reseeding is far below that which is in dire need of rapid revegetation. The areas offering greatest chance for success are the 20 million acres or so of abandoned cultivated fields in the Great Plains and in the foothills and high plateaus of the northern half of the western portion of the country and the several hundred thousand acres of depleted mountain meadows.

Other promising sites for range revegetation are the millions of acres of depleted foothills and mountain slopes, if not too steep, particularly from Colorado and Utah northward, the plains and mountains in the Pacific Northwest, and the depleted unplowed range land of the Great Plains having favorable soil and moisture conditions.

Although less promising for successful seeding there are millions of acres of depleted and badly eroding dry valley foothill and steep terrain in the mountainous sections of other parts of the West which require revegetation. Generally, structural aids for moisture conservation, such as contour furrows or terraces, are necessary under such conditions to assure establishment, although certain annual plants have been seeded successfully for erosion control following brush land and forest fires to serve until the native vegetation has time to reestablish itself. While research and practical trials are determining additional species that might be used to advantage, and methods that are less costly, most plantings under such conditions can be justified to date only for erosion control.

It is roughly estimated that about 1 of every 8 acres of western range lands should be seeded.

In the South and other parts of the eastern portion of the United States, moisture is ordinarily sufficient for successful seeding, but poor soil and competition from aggressive plants growing naturally in these regions is very severe. A certain amount of revegetation to plants which retain the nutriment longer than most native plants would be desirable to give better balance to range values. Seedings of lespedeza on range lands in the Ozarks and in other parts of the South indicate possibilities for improvement. On the basis of present knowledge it has been estimated that approximately 635,000 acres of Federal lands and 1½ million acres of private land need revegetation in the two eastern areas. Further study and experience may materially raise this estimate.

Optimum Use of the Range

Every manager of range land must have certain facilities in order to administer properly, efficiently, and economically his property and to develop and utilize its resources. The need increases more or less proportionately with size of holdings and varies with the character of the range resources and desirable intensity of their use. Many of the activities which are important from the standpoint of arresting range damage and bringing about improvement furnish correlative opportunities for better management. Fences, for example, as outlined earlier, facilitate best use of forage and increased and more profitable livestock production. Similarly, activities such as water development and noxious-plant control and even well-located driveways may be important in range forage betterment. Still, the major purpose will usually be to make it possible

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to obtain greatest value from the use of the grazing resource. Truck and other trails to reach all parts of the range conveniently and expeditiously and buildings and other structures to facilitate administration and management all play their part in bettering range use.

Water Developments

Water is just as essential to the welfare of livestock as forage. Accordingly, water should be readily available within easy walking distance and in sufficient quantity and of good quality at all times of the year that the range is used by livestock.

Sheep may often go from several days to several weeks without drinking, depending upon the abundance of succulent forage, the temperature, and the amount of rain and dew. Further, if they are properly handled, they can often, depending upon topography and other conditions, graze a range of from one to several miles radius from one watering place without serious detriment to themselves or injury to the range. Still, it is best to have more water available if it can be developed without undue cost. This is especially true on summer range in hot, relatively dry localities.

Goats have water requirements somewhat similar to those of sheep, but since they are most abundant in the Southwest and graze brush ranges at rather low elevations, goat ranges usually require more watering places than most sheep ranges. It is desirable to have water readily available for daily watering in hot weather.

Cattle need water at least every 2 days. In rough country they should not have to travel more than 1 mile, preferably half a mile, to water, and in level or undulating range not more than 2½ miles. Many cattlemen have proven that these requirements are modest. Even with water at these distances, local overuse will result. Supplemental watering places therefore are advised so that both vegetation and livestock may thrive.

Horses can go long distances to water and will of their own choice graze out on high open grass ridges far from watering places. There are relatively few range horses remaining, however, and water developments on most ranges are designed primarily for other classes of livestock.

The number and character of artificial watering places needing to be developed for livestock on a range depend, in addition to the kind of livestock, on such factors as the amount and availability of natural water, the amount and character of forage available, the desired season of use, and the natural conditions influencing use of the particular range by the kind of livestock grazed.

In a few areas there is sufficient surface water in streams, ponds, and springs, available when needed so that further development is not necessary. Also, nature may take care of stock watering needs temporarily, without artificial facilities, through rain lodging in natural depressions or through snows or dews, which furnish water to sheep and wildlife.

Good distribution of stock-water, especially when supplemented by effective salting of cattle and herding of sheep and goats, serves as one of the major factors in obtaining satisfactory distribution of livestock and uniform utilization of the forage during desired seasons. Inadequate numbers of, and poorly developed, watering places have been major factors in excessive concentration of livestock with consequent overgrazing in their vicinity. Some range areas having insufficient water supply for the number of livestock the forage will support have been little used. On other areas the water supply is sufficient for all the livestock the range will carry, but is not permanent, and the animals must, therefore, be removed before the grazing season is over. Still other areas are made extremely uncertain for livestock grazing purposes by the absence of water except at rare intervals during the winter when the presence of snow allows their temporary use.

In the main, the water development program will provide facilities in areas where there now is insufficient water or where water is not yet in an available form. This is especially true on semiarid range lands where furnishing water for livestock may be the major capital investment, equalling or exceeding the value of the livestock, and where in some places there is not now a single range livestock watering place in entire individual townships of 36 sections of land. The investment in, and current cost of operation of, water facilities in dry areas are often as costly as furnishing feed for livestock in those areas where rigorous climates require winter feeding.

On privately owned range lands of the West, establishment of livestock watering places has been a progressive development over the years, although many ranches have endeavored to get along with a bare minimum. In recent years many developments have been constructed under the various aids and services of the Federal Government. The problem is complicated by small holdings and the necessity of each individual having sufficient watering places on all parts of the range for a relatively small herd.

The water development needs have been estimated under three classifications: springs, reservoirs and wells.

Springs.—Probably springs have been more widely developed than other types of water in the West. Developments may involve only the simple task of fencing and impounding the source of a spring and installing a wooden trough made from local materials, or it may mean construction of a storage reservoir

and a pipe line of considerable length to the point of use. It is estimated that about 27,000 springs justify development on Federal lands in the West. Somewhat over 3,500 in the South and about 1,800 in the Northeast are suggested for development on Federal lands. On private lands about 110,000 springs justify development in the West, 10,000 in the South, and 1,000 in the Northeast .

Reservoirs.—Construction of reservoirs for livestock watering purposes may involve only placing earthen dams across small stream beds of intermittent flow or the gouging out of small depressions with drainage carried into them. Frequently, however, it is necessary to impound larger bodies of water such as may be caught in the rapid run-off characteristic of many intermittent stream courses in arid sections of the West that drain many thousands of acres of land. In rare instances concrete structures which require special technical engineering skill for their construction may be necessary.

Reservoirs frequently require protection against siltation. This sometimes can be provided by fencing critical areas above the reservoirs to control grazing and to permit the growth of a protecting vegetative cover. It is estimated that nearly 59,000 reservoirs will be required on western Federal ranges, many of rather large size on semi-arid lands. In the South and Northeast 380 reservoirs are estimated to be needed. Approximately 200,000 reservoirs will be needed on western private, State and county lands.

Wells.—It is estimated that 12,000 wells are needed on western Federal range lands. Most of these will be relatively deep, requiring drilling and rather expensive pumping equipment. The 500 or so required for the South and the 700 for the Northeast will be much shallower. In certain sandy areas of the Coastal Plain, water may be obtained by simply driving a sand point a few feet into the ground and installing relatively inexpensive pumps. The need for wells on the more extensive private, State, and county lands total 5,000 for the South and 500 for the Northeast.

Noxious Plant Control

The presence on range lands of nonpalatable vegetation, often poisonous, and by woody plants having low food value, is a serious problem. Once these uneconomic species become dominant they may continue so for many years unless artificially removed. Consideration of public interests, especially maintenance of optimum productivity of land make the reduction of the stand of undesirable plants an important and meritorious activity.

Poisonous plants take a heavy toll annually in death of animals and in their inadequate development, poor condition, and lowered sale values. They often force limited use or special management of otherwise valuable range. These constant losses hold back full returns from the industry.

A successful program has been under way for control of larkspur on limited areas of western ranges for a number of years, and control measures have been instituted in a more limited manner with several other poisonous plants. There are numerous poisonous plants, however, which are equally as important as larkspur and for which control measures are urgent. Few, if any, control programs should attempt eradication. The extensive character of the stands is ordinarily too great to make eradication possible. The problem is primarily one of reducing the stand or eliminating the plant in critical areas, such as along driveways, about corrals, and other concentration points. Some plants, however, will require more widespread action and treatment on critical areas as rapidly as proven methods of control at reasonable cost are developed.

Another group of plants justifying attention are those low value, seldom grazed species whose place may well be taken by palatable and nutritious vegetation. In most range areas the vegetative cover is limited by moisture. Each weed plant takes the moisture that a better plant might use in the production of desirable forage. Some shrubby species have become so dense that they greatly hinder the movement of animals and the effective harvesting of the forage growing on range lands. Some annual weeds which grow on depleted range serve as hosts to leaf hoppers which carry the disease, "curly top," to irrigated crops on adjacent cultivated lands.

Control measures vary widely, depending upon the plant concerned, conditions of soil, other vegetation, and other local factors. Suitable control measures are not available for all pests. The removal of dense sagebrush by well controlled burning on lands where there is sufficient perennial grass to carry the fire in periods of low hazard and to take the place of the sagebrush, can improve the usability and capacity of ranges. The seeding of desirable forage plants on ranges from which noxious plants have been removed may be necessary in order to assure adequate protection to the soil and the full values from the cost of the control measures.

Driveways and Trails

Easy movement of livestock, whether on a range area itself, between ranch and range, between ranges used seasonally, or for reaching shipping points in sending livestock to market is vital to the success both of administration of range lands and of the livestock business. The very extent of range land indicates the vast need for truck trails to open up grazing areas and for

driveways which are the ways for livestock moving on foot.

In the West few livestock graze on the same range area throughout the year. This is especially true from the Rocky Mountains westward. Certain low elevation ranges are used in winter or the livestock are kept at the winter ranch and fed. Most of these livestock are then moved into the foothills for spring grazing and many move on into mountains for the summer. In the fall as snow threatens, the livestock move back down on to fall ranges or to the deserts and ranches. Some of these movements, such as in Arizona, Utah, and Nevada, cover several hundred miles between summer and winter ranges.

Movement of livestock along roads and highways not only seriously impedes traffic but endangers the lives of the animals and more particularly the traveling public. Accordingly a whole system of driveways and livestock trails has been established to facilitate movement of the animals with minimum interference to other interests along the way. Such trails must be protected from promiscuous grazing, and must have as much forage as is possible to produce and water to serve the livestock as they move. Whenever it can be arranged, especially on driveways used for the movement of young lambs in the spring and later to market, it is well to have special reserved areas of forage for the animals. Where such driveways pass through dense timber or brush it is necessary to open them up in order to avoid injury or loss of animals.

Truck trails serve not only for occasional transportation of livestock but for the movement of supplies, equipment, and men, for ready access to fires, and similar uses. Such trails are not designed to duplicate county or State roads, but rather to supplement them in facilitating handling of livestock and administration of public areas.

Much of the range country is hilly and mountainous. On the higher and more rugged areas, especially those which have important watershed values, the management of livestock for uniform use of the forage without endangering other land resources presents a real problem. Trails to and from water and to otherwise inaccessible portions of the range greatly aid in better use. Often springs and other livestock watering places are located in very rough, deep canyons, and travel by cattle to and from them is difficult. When cattle are forced to travel rough and steep trails they naturally overuse areas that are close to water. In times of drought when forage is short and cattle are in a weakened condition, rough trails are a hazard to livestock; good trails on the other hand, may prevent loss. Travel on good trails requires less expenditure of animal energy, and cattle can, therefore, travel to outlying range areas without impairing production.

The estimated total of additional driveways and trails needed on Federal lands of the West is 33,000 miles, of which 18,000 are truck trails. In the eastern portions of the country approximately 1,300 miles of such driveways and trails are estimated to be needed. On private, State, and county lands of the West approximately 2,000 miles of trails are estimated as desirable.

Miscellaneous Range Improvements

Bridges are an important requisite to facilitate the movement of livestock into many important grazing areas. These may be of simple stringer design and of log construction suitable for use by livestock and vehicles or they may be of cable-suspension type suitable only for livestock use. Some 2,000 bridges are included in estimates for miscellaneous improvements. Other miscellaneous improvements include cabins, corrals, dipping vats, branding chutes, salt troughs, fly shelters, and many other facilities which serve the livestock industry directly in better management and in more economical operation. Some of these facilities, such as cabins and corrals, often serve to advantage also for trappers, hunters, and other recreationists who frequently spend a portion of the year in range areas.

Buildings for Administration

Administration of Federal range lands requires the construction of offices and homes for field administrative officers and of facilitating buildings, such as garages and store houses. It is desirable that these men live close to the range and at locations accessible to the public.

Additional Activities

In so large a program there are many activities of a miscellaneous nature. Present range programs include construction or activity items which form a guide as to the nature of the miscellaneous works here contemplated. Some of these activities include:

1. Inspect pest control (e. g., Mormon crickets);
2. Establishment of demonstration areas for range management;
3. General clean-up—disposal of old dump ground accumulation;
4. Boundary posting;
5. Posting of signs, markers, and monuments;
6. Preservation of relics of historic and prehistoric times;
7. Production of shade and shelter for livestock;
8. Placing of airplane markers and development of landing areas.

Land Use and Ownership Adjustment

The Federal Government in recent years has recognized the unsuitability of most of the remaining public

domain for disposal under the homestead laws, and has placed it under Federal administration. Full coordination of privately owned ranches with this and other Federally administered range land, and the more adequate development of the public and dependent private lands will go a long way in making many of these dependent ranches socially and economically sound. Even then, there will be many small outfits which will still have difficulty attaining a satisfactory living standard.

Federal Purchase of Range Lands

During recent years the Federal Government has undertaken to overcome some of the more critical submarginal farming situations by means of purchasing inferior farming land and converting it to more economic uses.[1] To date approximately 6 million acres of such land has been purchased in the range territory of the West. The object of the purchases in the range areas has been to balance the land resource with the population dependent upon it for support, thus permitting a shift from precarious and frequently disastrous cash-grain farming to a combination of forage crop and range livestock production. Emphasis has been placed upon the maintenance of the most efficient size of operating units for the type of agriculture best suited to a semiarid climate.

Substantial public purchases still are necessary to stabilize the economy of grazing areas, particularly in the Great Plains. Consideration of the amount of range land which may need to come under public ownership turns primarily on the question of how adequately the public interest will be safeguarded under private ownership and management of lands of low productivity. Millions of acres of range lands are seriously eroding and damaging other lands, and are yet of such low productive capacity that they approach submarginality for continued private ownership for grazing purposes. It may be best for the public to take over such land into its own ownership, not for the purpose simply of augmenting its range holdings but to guard land resources and other values. Extensive public relief efforts and subsidies in the form of soil conservation activities have undoubtedly aided in at least temporarily relieving the situation. If public agencies are to expend an amount several times the productive value of the land under any economic scheme of private ownership in order to assure protection of public interests, there arises the question whether the public should not spend a small additional amount and obtain absolute control. Public ownership would not in any event preclude regulated grazing use of the land by owners of livestock unless the land is dedicated to some special use, as a municipal watershed.

[1] This program, now administered by the Soil Conservation Service, was initiated with emergency funds in 1934 and 1935 and later carried on under authority of the Bankhead-Jones Farm Tenant Act of 1937.

Range Surveys and Plans

Planning has come to be recognized as a necessary part of the whole national program of conservation and development. Planning for range land use in its relation to conservation and development of the resource is just as essential as for any other resource or developmental effort. Facts and their effective interpretation are basic to effective planning. Surveys and investigations furnish the facts.

Probably less is known about range lands and their possibilities than any other major national resource. Only a small part of the total range area has been surveyed adequately. Moreover, resurveys will be needed from time to time as the character and amount of forage on the range changes, as the dependent ranch business is modified as a result of changing economic or other conditions, and as other uses and services of the land change in importance.

In general, surveys made for the development of plans for administration and management of range lands aim to provide adequate information on the land form, the vegetation and its relative condition and value, and soil and erosion conditions; to obtain an understanding of present use of the area by domestic livestock, and by wildlife, both desirable game and destructive animals, and of facilities usable for livestock production and other culture; and, finally, to consider needs for adjustments in use, coordination with other uses and services of the land, and desirable developments. In addition, range surveys on public lands acquire information regarding related ranch properties and their productive character in order best to coordinate the use of the public range lands with the dependent private range and other agricultural production. Special surveys are often needed to define specific problems and determine sound solutions.

Since a great part of the data collected by and interpreted in range surveys and plans are shown in graphic form reasonably accurate base maps are necessary. The lack of satisfactory base maps has been one feature that has greatly retarded effective range surveys. The recent developments and expansion of aerial photography has facilitated the preparation of satisfactory base maps and the handling of field work.

A completed plan of range management for an area should show what the range resource is, its physical condition, its relation to other resources, and how it may be best utilized, developed, and improved in the interests of individual and community welfare.

Range surveys were first developed on Federal lands and the plans prepared from them were primarily for

the use of Federal administrators in the management of lands under their jurisdiction. Often, there was no plan for the private land holdings within the operating unit, nor was the use of these lands always given adequate consideration in the plans for Federal lands. The operator, quite naturally has always considered his home ranch where his livestock is kept much of the time, as the most important part of his ranching unit. Plans which omitted consideration of these important privately owned lands were often neither understood by the operator nor effective in arousing his interest and support for the objectives the Federal plans were attempting to accomplish.

More recently there have been far-reaching efforts by the Soil Conservation Service to develop plans centeriny around the operation of each individual ranching unit. Such plans are developed step by step with the ranch owner in accordance with the peculiaritiese of his individual operation and the physical needs of his land. Where public lands are involved in the ranching unit, the "ranch plan" is properly related to the use of such public areas. This approach has resulted in a far better appreciation by the range operator of the objectives of range conservation planning and an understanding of the specific practices and methods which he must adopt to attain them.

The development of technically sound plans for construction of costly facilities requires specific surveys. Such specific surveys and plans ordinarily are considered as a part of a project and therefore are not estimated as to quantity in this report.

In connection with surveys of grazing land in Federal ownership, it is estimated that it will be necessary to cover approximately 300 million acres. This includes not only the Federal land but certain essential intermingled or otherwise dependent lands owned by the States, counties, or individuals. In the South it is estimated that nearly 12 million acres of range land should be covered by range surveys for plans on Federal lands, although this area includes a considerable amount of intermingled privately owned range land whose use is tied up with the effective administration and management of the Federal lands. In the Northeast it is estimated that somewhat over a million and a half acres of Federal and other closely integrated lands will have to be surveyed.

In the West roughly 400 million acres of State, county, and privately owned land not included in the above will need to be surveyed. In the South roughly 200 million acres and in the Northeast approximately 40 million acres of privately owned land will need to be surveyed if adequate plans are to be developed for their effective conservation and development.

Social and Economic Security

The picture of needs relating to range lands would not be complete without consideration of the necessity for overcoming the human wastage of the past from unwise settlement or oversettlement in range areas, from ill-advised efforts at range use, and from lack of the knowledge, facilities, and means of control which make it possible to use range to best advantage. The greater the sound development of the range resource and facilities for its use, the more assurance we will have for high standards of living, for stable communities and general social and economic well-being in the range area, and for reasonable prices of livestock products to the ultimate consumer.

In those localities where oversettlement has occurred, there will be need for furnishing relief employment from time to time to families who do not have sufficient opportunity to obtain the living standard which has come to be recognized as desirable in this country. Resettlement programs may relieve part of this pressure. Improved range conditions and greater opportunities for more profitable livestock production will in turn offer greater opportunities for the small livestock owner to use his time in his own operation, and for employment of additional local men in the operation of larger outfits. Such employment needs have been critical in recent years in the Ozarks and in many other parts of the South. Similar conditions of inadequate employment opportunities in the West are not so numerous; still, there are enough localities where such conditions have prevailed that public interest points the way to large-scale Federal action. Special mention should be made of the advantage to the Indian of livestock ownership and work as a means of livelihood and development of citizenship.

The private owner, as well as the public, has responsibilities for correcting unsound conditions. The owner operating on submarginal lands or on a unit that is economically unsound should recognize either the necessity for adjustments which will overcome unprofitable operations or for the abandonment of the endeavor to make a home under such adverse conditions. Those who remain must recognize that management principles which will rehabilitate depleted ranges and assure most effective use of the forage and reasonable returns from the livestock, need to be used. Inflationary land values must be written off, the range resources maintained, and a concept of good husbandry achieved to protect and encourage credit.

Hopes for quick profits, rather than conservative use with a permanent high standard of living, too often have been the incentive for stockmen and their financial backers in the development and use of the range re-

source. That use on a sustained-yield basis as the only approach to economic and social security for the range country, has received too little recognition. Sustained use of the range resource means more than conservation of the range. It includes a permanent stabilized system of integrated crop agriculture as well. Under such a system the recurring effect of drought years can be largely avoided. The light demand which is made on the grass and supplemental feeds during good years will build up reserves of forage, increase vigor of range forage plants, improve the soil, and allow an accumulation of harvested feed necessary to prevent excessive forced shipment of breeding stock during drought years. Although income may be less in the good years the net profit over the years will be far greater.

Both the public and private effort necessary to bring the range into full productive capacity will be large, but such efforts will result in substantial social benefits.

4. COSTS AND BENEFITS OF PUBLIC WORKS ON RANGE LANDS

Range land, whether in public or private ownership, is a basic resource. As such it should be treated and developed in such a way as to contribute maximum benefits to the Nation. The public now owns 360 million acres of range land. Contributions of tangible and intangible public benefits by the 610 million acres of privately owned lands imply public obligation to pay in part the cost of activities designed to improve these lands and use them to the fullest extent consistent with the perpetuation of good conditions for forage production, for watershed protection, for wildlife production, and for recreation.

Some portion of the Nation's range lies in nearly every State. Conditions vary widely; consequently the intensity and specific type of treatment needed will depend upon the local factors within the three broad regions—the West, the South, and the Northeast.

Costs

The costs of conservation and development of range land in Federal ownership will be far larger in the West than in other regions. Primarily this is due to a much larger acreage of public land in the West and a lack of development on this land. The major items of cost cover such necessary conservation activities as range improvements, soil and moisture conservation structures, revegetation or seeding, and other measures, all designed to increase the contributions of these lands to the Nation as a whole.

Costs per acre of public works on range lands are rather low. For works of the scope considered in this statement, the costs should average between one and two dollars per acre. This cost is in keeping with the relatively limited value of range land and the requirement of many acres per unit of livestock. Frequently the costs may be spread over a much larger area than that of the land actually treated, because of such off-site benefits as flood control or reduction of reservoir siltation.

Benefits

The main benefit to be derived from the suggested program is the attainment, at least in major proportions, of the broad objective, previously stated, to rehabilitate, develop, maintain, and manage the range resources of the Nation in such a manner that man may derive from the land maximum employment, benefit, and satisfaction consistent with the permanent maintenance of land resources. In view of the great extent of range lands and their part in furnishing essential needs of the Nation and a living to the population dependent upon their conservation and use, the benefits to be expected from a public works program are of very great importance.

Not only should a program assist in attaining the broad objective, but it also should aid in attaining the major aspects of practically all the specific objectives outlined in part II.

If, as it seems reasonable to anticipate, we can stop soil and forage depletion and replace it with soil building and forage improvement, the enormous wastage of the land, undermining of the livestock industry, and destruction of the wildlife population will be stopped, and the large losses from floods resulting specifically from depletion of the soil and its protecting cover on range lands will be checked.

If, in addition to starting the soil building and forage improvement processes, range lands can be made to produce their maximum of forage or other suitable plant cover, all uses and services to which the land may be put will be vastly benefited. Then, by using the improved range for optimum livestock production, the gross return to the livestock industry may be increased substantially through larger net production per animal and a higher quality of meat, wool, mohair, and other animal products. This larger production will be needed to take care of increased demands from increased population and will tend to keep prices to the consumer on a reasonable basis. Of even more importance will be the ability of the range area better to meet the impact of exceptional demand on range resources such as those which arose during World War I and which are again upon us.

The production of a full quota of forage upon range land should largely eliminate the extreme risks and hazards which have made the livestock industry so speculative. Greater forage reserves can be built up to meet the shocks of drought and other natural catastrophes. Improved coordination should be possible with other agricultural production in the range territories and related farm production in the Corn Belt and other feeding areas of the Nation. Thus, more efficient and more profitable operations are established. The net profit to the individual producer should increase and

in most instances the operator should be running in the black rather than in the red. Credit should be strengthened and financial failures are less likely to occur. The industry should be better able to pay equitable local, State, and Federal taxes. The social and economic fabric of dependent communities and even of whole regions should be strengthened.

Using the range in such a manner as to provide the optimum production of forage and of livestock and livestock products will not only benefit the private owner of land and livestock but will provide greater direct returns to the Nation from use of public lands by privately owned livestock. On most of the 360 million acres of public range a nominal charge is made stockmen for the use of the forage; also income is derived from the occupation of these lands for other special purposes. At the present time the annual income to the Federal and State Governments from fees and leases on range lands is approximately $5,000,000. With increases in productive capacity and facilities for more efficient utilization, greater income to the public may be expected. In some areas increased income alone should be sufficient to liquidate the expenditures.

An increase in plant cover on range land would not only check soil erosion, but through the development of a greater quantity of humus and root passages in the soil, would facilitate penetration of water to underground supplies rather than permitting it to run off in unusable condition or in damaging floods. Thus, water delivery to the several billion dollar irrigation enterprise of the West, and to hydroelectric power plants, municipalities, and other users would be better stabilized and in greater usable quantity, with less surface storage and therefore less expenditures needed for expensive reservoirs. The reduction in silting of irrigation, power, and livestock watering reservoirs would greatly lengthen their period of productive life and avoid the ultimate necessity of expensive periodical removal of unwanted silt. Even distant navigable channels would have less silt to be dredged.

Since range lands furnish the environmental conditions in whole or in part for most kinds of game, fur bearers, and other wildlife, improvement in the environmental factors necessary for wildlife maintenance from better range conditions, would aid wildlife conservation. At present there are some serious conflicts between big game and domestic livestock and in certain localities game animals alone are so numerous that they are undermining the resource on which they depend for existence. On the other hand there are many range areas which can support greater wildlife populations without endangering the forage resource or other uses or services of the land. Many of the facilities constructed for better protection and utilization of range land by domestic livestock and improvement through revegetation, would aid in stabilization and better utilization of wildlife. Hunters are far better satisfied with fat game animals than thin, poorly developed ones. Animal diseases due to malnutrition would be reduced or stopped.

Benefits to recreation from a program of activities in range conservation and development are purely subsidiary, but nonetheless important. Where nature distributed the water, sculptured the surface of the land, and provided plant growth to beautify the landscape, some localities were favored more than others. The presence or absence of water, for example, in a given locality may mean the difference between a desirable environment for all forms of life and one that is untenable. The water backed up by Boulder Dam creates an attractive lake and affords enjoyment to thousands of persons annually in an environment that was formerly severe and unattractive. In like manner but on a smaller scale the thousands of small reservoirs that comprise a part of this program of range conservation will improve the environment for wildlife and for men and afford immeasurable returns in human satisfaction in those communities now without such facilities.

The program for retiring submarginal farm land in the West has great value in the localities where it has been applied in relieving distressed farm families, in stabilizing the operations of those ranchers who have remained, and in safeguarding public interests against future despoliation of the range. The extension of the program would make possible greater consolidation of Federal holdings and provide additional opportunities to retire from cultivation land which, although usually unproductive when cropped, sometimes helps to glut the grain markets and depress grain prices to unprofitable levels.

Social Gains

Range grazing is a frontier type of occupation. Homes are far apart and the normal social benefits available to most communities are often lacking. If, through range conservation, it is possible to overcome the many financial handicaps affecting the industry, inadequate facilities, and lack of adequate forage, the business can be made more profitable and better stabilized. Elimination of the failures of the past, of the unproductive struggles to establish homes, and of the abandonment of schools and churches, while difficult to measure in dollars and cents, is the essence of providing a sound social structure.

Large opportunities for employment would be involved in a program for range conservation and development. Of first importance is increased employment

in the industry itself. Productive livestock outfits turning out the optimum of meat and other animal products carry their beneficial influence forward into financing, marketing, transportation, meat packing, the wool and mohair trade, and a great variety of related uses and industries. Indirectly at least, many millions of people are affected and depend upon the products of the range for their welfare and prosperity.

As a reservoir of direct employment, carrying out the proposed activities would furnish approximately 300 million man-days of direct employment at usual rates of pay. The materials used would furnish a large quantity of additional indirect employment. During the last 8 years, well over a hundred CCC camps were profitably employed in restoration and development work upon range and interrelated lands. Great numbers of people on relief also have been employed under various emergency programs, and a smaller number of other workers have been furnished more or less regular employment. The work still to be done is many times greater than the total accomplishments to date and should economic conditions again create unemployment in quantity, many workers could be absorbed in range conservation work of urgent need and high priority.

If our ranges are to do their part in furnishing stable employment, in aiding in times of economic stress, and in maintaining permanent, prosperous communities, they must be restored, developed, and managed in such a way that a sustained yield of forage is supplied for optimum production. While gains will be particularly important in the West because of the very size of the program for that part of the country, the critical living conditions in the South and in those parts of the Northeast that largely fall in native forage-producing lands, is so great that the gains to be made in those areas in social and economic betterment from a public works program also would be of great importance locally within those regions.

5. EVALUATION OF PUBLIC WORKS ON RANGE LANDS

In programming specific projects designed to aid materially in range development and in evaluating such projects, it is essential that certain principles be followed if uneconomic pitfalls are to be avoided. Persons actually engaged in the evaluation process will need to develop a list of general principles as a practical aid in carrying on this work, and to supplement it with further considerations of an administrative character.

Technical Soundness

Programs and projects must be technically sound and proven as to feasibility. Proper technical procedures in certain activities and sound engineering design and orderly construction in others must be based on adequate prior data which have been checked against needs shown by management information.

In the purely engineering activities procedures have been worked out and tried over many years. Range fires have been fought for a hundred years, and the newer mechanized methods of control are in operation in no small way. Fencing and water-development work is old and tried. Certain innovations to western United States have been perfected locally by ingenious settlers and put to the test by Civilian Conservation Corps work.

Where native and introduced plants are to be increased or changed, the research agencies and the work of enterprising agencies and individuals provide the basis of operations. In soil and moisture conservation efforts, there are certain standard principles which now have been proven.

Costs and Benefits

The following basis of evaluation is suggested as desirable:

1. Total benefits should exceed costs.
2. Benefits should be considered from three direct angles:
   a. Benefits to capital resources, considering the Nation as a landlord guarding and improving his domain. That domain consists of federally owned lands and State, county, corporate, and private lands in about equal amounts;
   b. Benefits through more orderly grazing operations and consequent improved production of grazing animals, and avoidance of loss and waste which have characterized range operations from early days;
   c. Social benefits which come from relieving unemployment by the prosecution of projects and from better and more lucrative use of a tremendous resource.
3. The summation of benefits may include nonmonetary and intangible factors affecting the welfare of the Nation—healing of signs of abuse and neglect, orderly and sustained land management which makes the public aware that its heritage is being maintained.

The costs of the proposed program could hardly be paid back in cash directly to the Treasury. Indirectly, however, through increased national returns from livestock and increased values and services from the land benefited, a reasonable return may be anticipated. The costs may be weighed against benefits which have been described generally in a preceding section.

Financing

Certain public works are for the furtherance of present activities on public or private land according to accepted principles of governmental responsibility. These might well be financed in whole or in part by the public, as administrative effectiveness depends upon them, and the interested administrative agency is available to oversee the maintenance of the improvements. Responsibility for maintenance should be established upon initiation of projects. As a general principle, a party whose operating expenses are reduced by a project should make prior agreement to maintain it.

The ultimate distribution of costs of activities and possible offsets should be distinguished from the original advance of funds. A part of the expense on public lands may be returnable to the Treasury in fees to be collected from users of these lands. Where other lands are affected the return is through less evident channels, such as income taxes on increased earnings of rangemen, associated businessmen, and farmers.

In periods of relatively high employment, the persons receiving benefits in the form of increased income or services directly traceable to public works ordinarily should pay the cost directly or through local government. The Federal Government should assume the costs when benefits are so widely distributed or intangible that they contribute to unnamed beneficiaries or to an important national policy or function.

In periods of heavy unemployment or in depressed areas, the Federal Government may properly assume such additional portions of the cost as may reasonably

be assigned to the relief of unemployment and the stimulation of the economic system.

There are two problems involved: financing the accomplishment of activities and projects, and paying for the maintenance of them. Various agencies, organizations, and individuals will assist in financing construction. Fire associations and land-managing agencies cooperate in planning, building, using, and maintaining fire-control facilities. States and counties assist in construction of truck trails and bridges, and often will take over maintenance. Fences are integral with ranch and range operations, and financing of materials and labor for construction is commonly provided by ranchers. Maintenance should be accepted by the most interested user or users, especially when the works are on private land.

State or county governments, associations, corporations, and other groups may be interested in financing a program of public works. Recent changes in land-managing viewpoints of these agencies are putting them into active participation. With due allowance for the fact that the size of the program on areas controlled by these interests is so great that it makes local financing difficult, one good measure of the value of an activity or project is the percentage of volunteered financial aid.

Relation to Regional and Functional Plans

Preferred status should be given projects which become an integral part of Government agency operation. For such projects there is assurance of maintenance of works. Other projects proposed by organized groups such as grazing associations, or soil-conservation district supervisors, as part of recognized programs should receive favorable ratings.

Priority

1. Certain priorities arise from the nature of projects.
2. Most priorities should be determined according to cost-benefit ratios, arrangements for financing, and relation to local and broad social values.

From the practical viewpoint of land management it is necessary to examine, map, and inventory resources to secure further information applicable to proposed activities. Fortunately, however, present information will allow immediate public works activity on a broad scale. It then becomes the duty of fact gatherers and planners to keep ahead of the works program.

There is a difference in the nature of the cost-benefit ratios. Those activities which improve husbandry and the financial return from use, show quicker cash returns. Those that deal with basic protection and improvement are slower in showing returns, but entail a long list of ultimate benefits.

Timing

1. Timing of projects should be planned to give the greatest remedial effect on both long-term and short-term dips in the economic cycle. Departures from this rule will be necessary to meet the needs of emergency projects and situations.
2. Administrative considerations, such as continuity of program, effective use of personnel, and assurance of local cooperation, are also entitled to some weight in making decisions on timing.

Range projects may furnish either long- or short-term employment. The activities of soil and moisture conservation, range improvements, and revegetation cover a wide field of employment, including much unskilled labor. The construction programs may give preference to materials and equipment which would grant employment to distant industry and transportation, or may be adjusted to massed local employment. For example, culverts in truck trails may be of corrugated iron, concrete, of hand-laid local rock, as the employment demand varies. Fence posts may be of steel, or of wood shipped from distant areas or locally cut and hauled. Power machinery may be used on contour furrows or other land treatment; or the work may be done with local teams and by hand.

Much of the work can start or stop on notice. Administrative preference leans toward continuity of action, but plans may be adjusted to short working periods.

Over-all Evaluation

The opportunities and needs for public works on range lands are great. In order to attain the desired range conservation objectives, each project must be a coordinate part of a unified program. The specific objectives will vary from place to place and between public and private ranges, but the major objective of optimum service of the range land to the Nation's welfare should always be paramount. Criteria to determine the extent to which the project and program aid in attaining the desired objectives, and to otherwise evaluate it will depend upon particular conditions and situations. Advice and counsel of stockmen, local community organizations and other interested public agencies should aid public officials in the planning and programming of public works on a sound and constructive basis.

PART III—PUBLIC WORKS AND FOREST LANDS[1]

1. INTRODUCTION

For 300 years the American people have been building up a civilization by consuming the natural resources of half a continent. Access to abundant resources, combined with the genius and industry of our people, has made possible our high standards of living and civilization.

One of the richest of these resources has been our forests, which originally occupied almost half and still occupy one-third of the land area of continental United States. Throughout our history, wood in its various forms has been an essential material for housing and for a multitude of other uses in homes, on farms, in mines, and in transportation and manufacturing industries.

Forests also serve us in other ways than as sources of wood. In some cases these other services are more important than the use of forest land for timber production. Forest cover on our hill and mountain land is essential to preserve the soil, to maintain regular flow of rivers, and to assure adequate supplies of water to agriculture, industries, and cities.

Forest cover on a large part of our forest land creates pleasing landscapes, ameliorates local climate, and affords opportunities for health-giving physical and mental recreation that are sorely needed as an escape from the tensions of cities and factories. Forest ranges are closely integrated with the economic welfare of thousands of stockmen in the West and of farmers in the South and elsewhere. Wildlife is an important forest resource.

The exploitation of the forests and the utilization of their products and services during three centuries have been based for the most part upon a prodigal use of these resources, without adequate provision for their renewal or for maintenance of their capacity to produce wealth and services. This prodigality was perhaps to be expected during the pioneer era. But the Nation is now mature and must assume the responsibilities of maturity. These include the obligation to establish, through rehabilitation and good management of the forest land resource, a more solid foundation for the livelihood and welfare of present and future millions of our people.

Forest resource conservation offers one important means of maintaining a balanced rural economy and social structure wherever timber will grow, by utilizing forest land for the purposes for which it is best suited, maintaining forest industries in perpetuity, and contributing to a healthy, diversified life for much of our rural population.

Forest land, like farm land or a factory site, cannot be kept productive without investment of capital. The capital that was present in the virgin forests has been largely liquidated or destroyed. A large part of the expenditures for restoring timber capital and for constructing facilities for development and utilization of the forests will represent nonrecurring investments which will add to the value of the Nation's productive plant.

These works in themselves will provide a large volume of useful employment. Such employment will be eminently suitable for utilizing surplus labor and supplementing other employment in rural areas. Although these nonrecurrent works should be undertaken without delay and carried forward vigorously, the volume of the work to be done is so large that much of it can be treated as a reservoir to stabilize employment. With careful planning, the work can be expanded on fairly short notice, when supplementary employment is most needed, and can be continued on a more modest scale during periods of greater economic activity.

This report has been prepared with two purposes in view. The first is to give an analysis and explanation of the present and potential place of forest land use in the Nation's economy as an aid to the long-range planning with which the National Resources Planning

[1] This statement was prepared under the direction of a committee consisting of Raymond E. Marsh, Forest Service, Chairman; Lawrence F. Cook, National Park Service; Alfred E. Fivaz, Soil Conservation Service; and Ellery A. Foster, Bureau of Agricultural Economics. Contributions were made by Crawford R. Buell, John R. Camp, Perkins Coville, Howard J. Eberly, Kester D. Flock, Raymond F. Grefe, Lawrence S. Gross, B. Frank Heintzleman, Howard R. Jones, E. S. Massie, Jr., D. W. Nichols, Robert W. Putnam, Gordon R. Salmond, Ivan H. Sims, and William N. Sparhawk, of the Forest Service; Frank C. Craighead and James F. Martin, of the Bureau of Entomology and Plant Quarantine; and others. Much of the assembly and revision of the statement is the work of William N. Sparhawk of the Forest Service.

Since this statement was written, months of defense preparation and war activities have placed a very heavy burden on forest lands and forest industries. This demand has resulted in a considerable sacrifice of the growing stock in many areas. The impacts of war have thrown into sharp relief the importance of the Nation's forest resources and of the attendant forest problems. The public works program on forest lands here described, therefore, assumes increased significance. Also, the quantitative information on forest resources, growth, drain, etc., requires interpretation in the light of the changing conditions resulting from the war.

Board is concerned. The second purpose is to serve as a background and guide for the current consideration and evaluation of public-works projects in relation to each other and to other phases of land use as they are submitted from year to year.

The final chapter presents a series of programs which are particularly suitable for consideration in connection with public-works planning. These public-works programs are based largely upon timber production and the watershed services of forest land. Forests and forestry must, of course, be conceived much more broadly than merely in terms of timber production. The maximum public benefit from forests will be assured only if all of their products and services are taken into account in thoroughly integrated management. It should, therefore, be kept in mind that no less important in the broad concept of forest conservation are the forest-land segments of other reports prepared for the Board on the grazing, recreational, and wildlife uses of land, including forest land.

2. FOREST-RESOURCE CONSERVATION NATIONAL SIGNIFICANCE AND OBJECTIVES

American forest-resource conservation sets up the ideal of the forest as man's living and permanent possession. Properly managed, the forest can renew itself and yield its goods and services indefinitely, contributing enormously to national wealth and well-being. Indeed, the preservation and use of forest land, the production and use of forest products and provision for other services find justification only as they benefit human society.

The Forest-land Resource

The forest-land resource, including associated range, brush, marsh, and water, is an empire in area and should be no less in opportunity.

One-third of the land area of the continental United States exclusive of Alaska, or 630 million acres, is forest land. This is half again as much as our farm-crop land. Nearly three-fifths is east of the Plains, in the area which contains more than four-fifths of our people (fig. 1). The ratio of forest to the total land area in individual States ranges from less than 2 percent to more than 75 percent.

Future shifts from forest into other uses seem likely to be localized and relatively small. On the other hand, the United States has many millions of acres where the soil has been so badly damaged by cultivation and erosion that it is submarginal for farming. Some day these lands may again be needed for cultivation; meanwhile, there may be no better or cheaper means of rebuilding them than through restoration to forests.

The Multiple Uses and Services of Forests

Too often we think of forests in terms of timber only. But in fact forests serve at least six major purposes, each of which constitutes a large and essential phase of our national life. These major purposes or uses are: (1) Timber production; (2) conservation of water and regulation of run-off; (3) stabilization and rebuilding of the soil; (4) provision of recreational and esthetic value; (5) support and shelter for wildlife; and (6) production of forage for domestic livestock. In certain areas forests protect buildings and crops against wind and other adverse climatic conditions. They may contribute to national defense through concealment of military structures and troop movements. A large area may serve all six major purposes at the same time.

Timber Production.—Timber growing is the most tangible economic use for forest land. Furthermore, timber can be grown almost anywhere that land is available and with less cultural effort than almost any other land crop. No other crop has greater flexibility as to time of harvesting, or even approaches timber in the accumulation of the basic plant materials, cellulose and lignin.

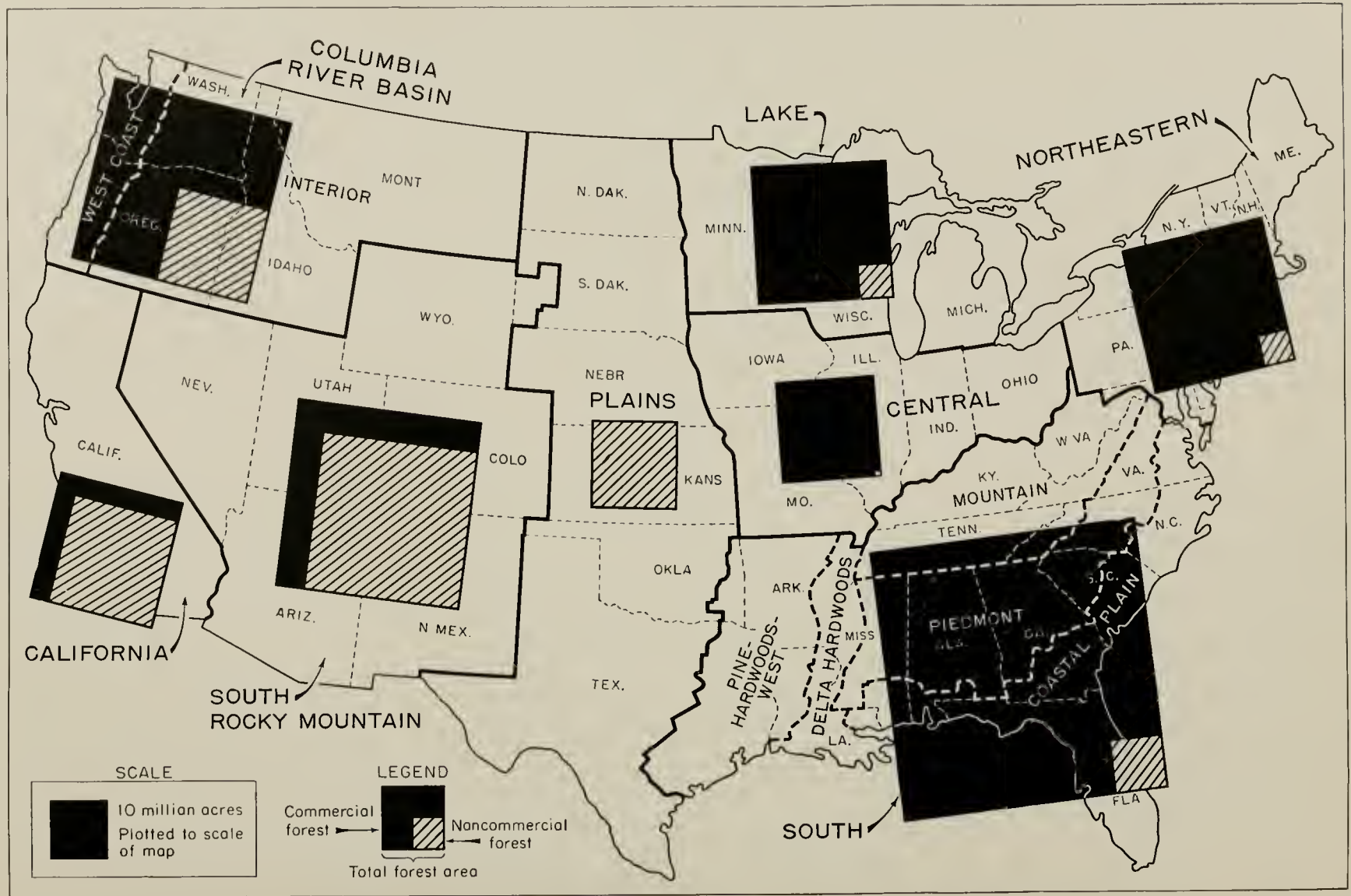
American economy has long been characterized by a high rate of wood consumption. Ample timber supplies are essential to our national wealth and well-being. Wood is an exceedingly adaptable material. It is used just as it comes from the forest, with only crude shaping, for fuel wood, poles, posts, house logs. It is used in a further-processed form as sawed lumber, veneer, shingles, flooring, barrel staves. It is the principal material for innumerable fabricated products—boxes, furniture, woodenware, musical instruments. It appears in a constantly increasing variety of chemical products—pulp, paper, rayon and other textile fibers, cellophane, acetone, alcohol, plastics. And the full possibilities of wood have not been touched—how to use it most effectively; how to treat it for resistance to decay, insect attacks, and fire; and, finally, how to transform it into new materials.

TABLE 1.—*Forest-land areas of the United States* [1]

Region	Total forest land	Commercial forest land [2]	Noncommercial forest land [3]
	Million acres	*Million acres*	*Million acres*
Northeast	62.2	59.4	2.8
Central	29.3	29.2	.1
Lake	55.6	[4] 52.4	3.2
South	210.6	202.5	8.1
Columbia River Basin	99.5	73.8	25.7
California	48.2	13.7	34.5
Southern Rocky Mountain	102.6	30.7	71.9
Plains	22.2	[5]	22.2
United States	630.2	461.7	168.5

[1] Exclusive of Alaska, Puerto Rico, and Hawaii.
[2] Land capable of producing timber of commercial quality and quantity, and available for commercial use.
[3] Woodland and brushland producing small quantities of small material, some of which may be used locally but which is not suitable for commercial use or is too inaccessible for such use; also lands producing timber of commercial quality that have been set aside in parks and other preserves.
[4] About 2½ million acres in the Lake region, classed here as commercial forest land, has been reserved for other use.
[5] All of the forest land in Plains region has been classified here as noncommerical, although some of it produces good timber. Probably at least 3 million acres is "commercial" under the definition given above. The proposed program of timber-resource development includes stand-improvement work on 700,000 acres in the Plains region.

Wood is the basis of an enormous number and variety of industries. Lumbering is one of our great industries. Forest product industries in 1929 employed about 1¼ million persons and produced commodities



Relative Forest Areas, by Broad Classes and Regions.

FIGURE 1.

U. S. Forest Service

valued at about 5 billion dollars. This does not include persons engaged in forest administration, protection, and planting, and in dependent trades and services.

The use of forest land for growing timber thus not only furnishes essential consumption goods but supports industries and communities, supplies tonnage for railroads and ships, and is the basis of many thousands of service jobs.

Commercial forest land—land capable of and available for producing timber of commercial quality and quantity—occurs in significant areas in all regions except the Plains (fig.1). The South, with 203 million acres, is far in the lead. Next is the Columbia River Basin, with 74 million acres, including the Douglas-fir belt of western Oregon and Washington (table 2).

TABLE 2.—*Commercial forest areas of the United States,*[1] *by character of growth*

Region	Saw timber [2]			Cordwood [3]	Restocking [4]	Nonrestocking [5]
	Total	Old growth	Second growth			
	Million acres	*Million acres*	*Million acres*	*Million acres*	*Million acres*	*Million acres*
Northeast	21.1	8.0	13.1	15.4	14.7	8.2
Central	9.7	.4	9.3	8.6	5.2	5.7
Lake [6]	7.1	3.6	3.5	10.8	13.5	21.0
South	96.7	25.1	71.6	47.9	29.1	28.8
Columbia River Basin	44.1	37.2	6.9	12.0	8.5	9.2
California	11.4	8.6	2.8	.2	.2	1.9
Southern Rocky Mountain	22.7	17.9	4.8	5.9	.2	1.9
Plains [7]	...	...	...	...	...	...
United States	212.8	100.8	112.0	100.8	71.4	76.7

[1] Exclusive of Alaska, Puerto Rico, and Hawaii.
[2] Areas characterized by timber large enough for sawlogs in accordance with the practice of the region. Old-growth areas bear uncut or lightly cut stands of mature timber; second-growth areas bear immature saw timber with at least a minimum volume per acre, which varies with the region.
[3] Areas characterized by timber large enough for cordwood but too small for saw timber; this ordinarily means young growth.
[4] Land on which at least 40 percent of the space is occupied by young trees of commercial species, predominantly below cordwood size.
[5] Land that is less than 40 percent stocked with young trees of commercial species.
[6] About 2½ million acres in lake States, which has been withdrawn from commercial timber production, is included here because breakdown by character of growth is not known.
[7] Only a few thousand acres in Plains region has been classified as commercial forest area. Probably at least 3 million acres could be so classified.

Not all of this land is now producing timber in the quantity or of the quality that it is capable of producing. A large portion of the land that has been cut over is only partly productive. Many growing forests are characterized by heavy proportions of inferior species and low-quality stands of the more valuable species. Building these up into satisfactory growing stocks is a major problem, especially in the East. Almost 77 million acres is largely idle land, much of which should be planted with trees.

Conservation of Water and Soil.—The beneficial effects of forest cover in regulating stream flow and preventing erosion may well represent greater values than the timber crop. Indeed, in many areas the "water crop" alone justifies maintenance of the forest. Forested lands exercise such a favorable influence in regulating stream flow and minimizing floods that no effective plan for flood control can ignore them. The function of forest cover in keeping the water of springs, streams, and reservoirs clear and pure for domestic use is universally recognized. Dependable supplies of clear water are equally essential to western irrigation agriculture. The importance of clear and permanent streams to fish and to recreation generally is perhaps not so widely appreciated.

The destruction of forests is a major factor leading to erosion on a large scale. Not only does erosion deplete the fertility of the land, but irregular and uncertain stream flow and deposits of silt and sand can largely destroy the value of the huge investments that have been made in dams, levees, and channel and harbor improvements. With a growing recognition of the extent of the erosion evil, reforestation as a control measure is being employed more widely each year.

On half of the forest land, the vegetative cover exercises a major influence in regulating run-off and checking soil erosion; on almost a quarter more, a moderate influence. Most of the remainder is comparatively level land, swamp and overflow land, or land having deep sandy soils, where run-off and erosion problems are not serious.

Unfortunately, there are large areas where the influence of the forest is not as beneficial as it might be, because of the present condition of the forest cover. A satisfactory forestry program would provide for creating favorable forest-cover conditions on practically every stream that is important for water supplies or navigation, or that is subject to destructive floods.

Little forest land need be withheld from timber or other use for the sake of the protective function. In general, forest land that is well managed for timber production will fulfill its protective functions at the same time. Besides timberlands, there are large areas covered with inferior tree growth or brush which have high value for conservation of water and soil and require protection against fire and overgrazing.

Recreational Use.—Recreation is an exceedingly important use of forest land. Practically all forest land has recreational value. Some has such exceptional value that it should be withdrawn from timber and grazing use. This includes areas of exceptional scenic and inspirational value, wilderness areas, wooded strips along highways, campgrounds, land needed for forest-home sites, and areas to satisfy intensive needs of large numbers of people. Eleven million acres of forest land has been withdrawn from timber production for recreational use. This acreage may eventually be greatly increased. It cannot be too strongly emphasized, how-

ever, that lands which are also being used for timber and forage production have high recreational value.

Wildlife Production.—Forest lands provide the environment and sustenance for many classes of game, fur bearers, and other wildlife of great social or economic value. Encouraging progress has been made in forest-wildlife conservation, yet, except in a few areas, the wildlife population is far below what forest lands and waters can support in balance with other uses. By use or misuse of forests and waters man upsets the balance of nature. Wildlife management and timber and range management, effectively integrated, can create and maintain a new balance. The protection of forest land from fire and the application of desirable silvicultural measures in using the timber contribute to the welfare of wildlife.

Forage Production.—About 342 million acres of forest land, chiefly in the Western, Southern, and Central States, is grazed by domestic livestock. A large portion of the cattle and sheep raised west of the Plains and of the cattle and hogs in the South live on forest ranges during part of the year. The forage-producing capacity of large areas of forest range land, as well as its timber-producing capacity and its value for watershed protection, has been seriously impaired by overgrazing and, especially in the South, by promiscuous burning. Proper management, together with essential range-improvement works, will largely increase the carrying capacity of these ranges.

Influence of Ownership on Forest-Land Use

The character of ownership (table 3) is one of the most important factors that determine policies of forest-land use. Each class and form of ownership or control has its inherent advantages and limitations. Objectives of owners within the same class vary widely. The ownership pattern in many places is so complex that it constitutes a serious handicap to effective forest management.

The primary objective of most private owners is to gain direct financial returns or, as in the case of farm woods, to procure wood products for the owner's use. The manifold other services of the forest do not ordinarily afford direct income to the private owner, and consequently seldom have much influence on his policy of forest-land use. Yet these non-revenue-producing uses are of great concern to the public generally.

Better understanding of forestry principles and a growing realization of the financial soundness of continuous yields are being reflected in better forest management by some owners. But in varying degree many private owners may ignore the public interests. On a substantial acreage of land now privately owned this will be so serious that public ownership will be necessary.

Public ownership—Federal, State, or local—differs from private ownership in objectives, stability, and financial ability. Under public ownership timber, forage, and wildlife uses can be placed on a sustained basis. Special areas can be dedicated as needed to any one of the major uses as the paramount one. The full potentialities of multiple use can be more nearly realized.

Private Ownership

Of our 630 million acres of forest land, 434 million is in private ownership. (See table 3.) This includes three-fourths (341 million acres) of the commercial, and more than half (93 million acres) of the noncommercial forest land. Private owners hold most of the better and more accessible forest land, which represents possibly nine-tenths of the potential timber-growing capacity of the entire country. This land contains nearly three-fifths of the remaining saw timber and furnishes more than 95 percent of the timber cut. It comprises nearly two-thirds of the important forest covered watershed areas.

TABLE 3.—*Ownership of forest land in the continental United States, 1938* [1]

Ownership class	Total	Commercial	Noncommercial
Private:	*Million acres*	*Million acres*	*Million acres*
Farm woodland	185.5	138.8	46.7
Other	248.3	202.1	46.2
Total	433.8	340.9	92.9
Public:			
Community	7.8	7.1	0.7
State	19.0	16.9	2.1
Indian reservations [2]	12.0	6.4	5.6
National parks and monuments [3]	6.5		6.5
Public domain	24.0	4.7	19.3
National forests	122.0	81.5	40.5
O and C lands	2.6	2.6	
Other Federal	2.5	1.6	0.9
Total	196.4	120.8	75.6
All classes	630.2	461.7	168.5

[1] Exclusive of Alaska, Puerto Rico, and Hawaii. Later estimates (1940) show somewhat larger areas in all public holdings other than national forests.
[2] Held in trust for the Indians, by Federal Government. Recent estimates raise this figure to 16.8 million acres.
[3] Recent additions and revisions raise this figure to 9.1 million acres.

Farm Woodlands.—Nearly one-third of the commercial forest land, or 139 million acres is farm woodland. (See table 4.) Mostly in small tracts, this is owned by some 3,500,000 farmers. This type of ownership is well adapted to keeping forest land productive. Ownership is fairly stable. Management usually requires only part of the farmer's time and requires but little cash outlay. Woodland products supply many farm needs, and in many instances are capable of yielding a considerable cash income. But the income-producing potentialities of timber crops have seldom been fully appreciated, and farmers generally have lacked knowledge of timber values and of silvicultural principles and methods. Although the number of well managed farm forests is increasing, there is some 20 million acres in

need of planting, and possibly 75 million acres of deteriorated forests that will have to be rehabilitated if production is to be increased to a reasonable level.

TABLE 4.—*Ownership of commercial forest land in the United States, 1938*[1]

Region	All areas	Federal				State and other public	Private		
		Total	National forest	Indian[2]	Other		Total	Farm	Other
	Mil. acres	*Mil. acres*	*Mil. acres*	*Mil. acres*	*Mil. acres*	*Mil. acres*	*Mil. acres*	*Mil. acres*	*Mil. acres*
Northeast	59.4	1.5	1.3	------	0.2	3.5	54.4	17.1	37.3
Central	29.2	1.4	1.3	------	.1	.2	27.6	20.4	7.2
Lake	[3]52.4	6.8	5.5	0.8	.5	14.1	31.5	15.0	16.5
South	202.5	12.9	11.4	[6]	1.5	1.7	187.9	83.6	104.3
Columbia River Basin	73.8	42.1	34.8	3.4	[4]3.9	4.0	27.7	2.3	25.4
California	13.7	6.8	6.7	.1	------	.1	6.8	.3	6.5
Southern Rocky Mountain	30.7	25.2	20.4	2.1	2.7	.5	5.0	.1	4.9
Plains[5]	[6]	[6]	[6]	------	------	------	------	------	------
Total	461.7	96.7	81.4	6.4	8.9	24.1	340.9	138.8	202.1

[1] Exclusive of Alaska, Puerto Rico, and Hawaii.
[2] Owned by the Indians but managed by Federal Government.
[3] Includes about 2.5 million acres withdrawn from commercial use.
[4] Includes 2.6 million acres of O. & C. lands under jurisdiction of the General Land Office.
[5] All of woodland in Plains region, except small planted national-forest tract, classed as noncommercial. (See footnote to table 1.)
[6] Less than 50,000 acres.

Industrial and Other Nonfarm Ownership

About 202 million acres—more than two-fifths of our total commercial forest land and from which comes the great bulk of our more important timber products—is owned by corporations and individuals other than farmers. About one-third of this is in about 1,700 comparatively large holdings, each of more than 5,000 acres. Some 300 of these holdings with an aggregate area of almost 50 million acres, comprise more than 50,000 acres each. Many of these large holdings are not in solid bodies, but are broken up into noncontiguous parcels, intermingled with other properties. This handicaps systematic protection and management. There are, moreover, hundreds of thousands of small tracts held by absentee owners who are in no position to carry on sustained timber management.

Industrial and most other nonfarmer owners have generally followed the policy of liquidating the timber resource—the opposite of sustained timber management. Many owners, large and small, have undertaken to dispose of the land in one way or another as soon as possibilities for immediate revenue have been exhausted. Millions of acres of cut-over land have been sold for farming or allowed to go tax delinquent. Much of that sold for farming has turned out to be submarginal for that use.

Recently, particularly during the last decade, there has been a striking change for the better in the management of industrial holdings. Nevertheless, there is still a long way to go; 174 million acres, or more than 85 percent of the privately owned nonfarm forest land, is not under any form of management. Some 60 million acres of this is not even given organized protection against fire. At least 37 million acres will have to be planted if it is to produce commercial timber within a reasonable time. On many millions of acres now bearing second-growth stands the growing stock must be built up and the composition of the species improved.

Public Ownership

Of the 196 million acres of forest land in public ownership, 170 million acres is owned or managed by several agencies of the Federal Government, and the rest by States, counties, and local communities.[1]

Community forests.—Counties, cities, towns, and other local public agencies own some 8 million acres of forest. More than a thousand of these forests, aggregating 3 million acres, are under administration and development. Thousands of communities throughout the country have a great opportunity for a large expansion in the number and area of community forests. Such forests can yield wood and timber for community use or for sale, protect water supplies, and afford opportunities for recreation. The management of these forests will furnish employment to local citizens and income to the communities.

State Forests and Parks

Each of the States owns some forest land; all together own about 19 million acres. About 8 million acres is in game refuges and scattered tracts which are generally protected against fire but seldom under systematic management. About 11 million acres has been designated as State forests and parks, mostly in 10 States—New York, Pennsylvania, Minnesota, Michigan, Montana, Idaho, Washington, New Mexico, Wisconsin, and Massachusetts.

The policies of the several States with respect to State forests and parks are diverse. Almost all are protected against fire and trespass. On more than half of the State forest area timber management ranges downward from intensive cultural operations and controlled cutting, with Arizona, Connecticut, Idaho, New Jersey, New Mexico, Pennsylvania, and Vermont among the more progressive States. About 60,000 acres was planted in 1938, mostly in Indiana, Michigan, New York, New Jersey, Pennsylvania, Washington, and Wisconsin. Management and protection have been materially expanded and intensified through Civilian Conservation Corps, Works Progress Administration, and other labor paid from emergency funds. The possibilities for State ownership and management of forest land have hardly been scratched in most States.

[1] These are estimates of 1938. More recent estimates show about 207 million acres in public ownership, of which 176 million acres is under control of the Federal Government.

Federal Ownership Other Than National Forests

Most of the Federally owned or controlled forest land is under the jurisdiction of the Departments of Agriculture and the Interior. Other agencies such as the War and Navy Departments control relatively small areas.

Public Domain and Grazing Districts.—The unreserved public domain (not including Alaska) and the grazing districts, under the jurisdiction of the General Land Office and the Grazing Service, respectively, of the Department of the Interior, include 24 to 25 million acres of forest land, all in the western States. Probably one-fifth of it is commercial forest land. Much of it has range values and nearly all is important for watershed protection. Provision of funds for forest fire protection prior to 1939 had been either lacking or sporadic. Limited funds are now available for the protection of these lands. Most of these forest ranges are now under grazing-district management.

Indian Reservations.—Indian forest lands aggregate 12 million acres,[2] of which about half is classed as commercial. These forests are administered by the Department of the Interior, under methods designed to yield maximum returns to the Indians consistent with sustained yield, good silviculture, and watershed protection.

Oregon and California Railroad Revested Lands.—These lands, which include some 2.6 million acres of forest land in western Oregon, are under the jurisdiction of the General Land Office of the Department of the Interior. They occur in alternate section pattern, checkerboarded with private forest lands and in some locations with national forest lands. They include 45 to 50 billion board feet of saw timber, some of it the finest in the West. On account of their accessibility to market, large volume of timber, and high timber-growing capacity, their importance from the timber-use standpoint is greater than would be implied by their relatively small acreage.

The Act of August 28, 1937 (50 Stat. 874) laid the foundation and framework for a sound forest policy on the O. & C. lands. This measure provides for the conservation of land, water, forest, and forage on a permanent basis; the prudent utilization of these resources for the purpose to which they are best adapted; and the realization of the highest current income consistent with sound administrative management. These resources are administered under principles of cooperative sustained yield in order to provide perpetual forests which will serve as a foundation for continuing industries and permanent communities.

National Parks and Monuments.—In the national parks and monuments, managed by the Department of the Interior, are some 6.5 million acres of forest land. As the forest cover must be kept in its natural condition and therefore is not available for commercial use, the forests are classed as noncommercial. They are of major importance for recreation and inspiration, and are also of value as wildlife preserves and in watershed protection.

Miscellaneous Federal Ownership.—The national wildlife refuges, administered by the Department of the Interior's Fish and Wildlife Service, contain about a million acres of forest land. The timber is protected and, except in special cases, cutting of it may be permitted.

In the areas administered under title III of the Bankhead-Jones Farm Tenancy Act of 1937, about 1.5 million acres of forest land has been purchased by the Department of Agriculture in connection with the program for retiring submarginal agricultural land. On some areas timber stands have been improved. Many of the areas have been intensively developed for recreational use or wildlife, and for watershed protection. Transfers to agencies such as the Fish and Wildlife Service or the Forest Service, or leases to State agencies, have been made, are in progress, or are planned.

National Forests

National forests or forest purchase units[3] are located in 40 States, Alaska and Puerto Rico. The net area of the national forests, exclusive of Alaska and Puerto Rico, is 156 million acres; about 122 million acres is forest, the remainder intermingled grass, brush, and alpine country. Private and other holdings inside the national-forest boundaries amount to 52 million acres.

The national forests, administered by the Department of Agriculture, represent the first large-scale trial in the United States of public ownership and administration of a great natural resource. They also represent the country's first large-scale classification of land on the basis of recommended use. Their withdrawal has kept a large area of submarginal land out of cultivation and has retained under public control millions of acres that is submarginal for private ownership.

The national-forest timber resource is being built up through intensive, carefully planned protection, by planting, and by silvicultural measures. All cutting is in accordance with management plans. Communities and industries dependent on the cutting and manufacture of the timber from the national forests are stable, in contrast to many communities engaged in the liquidation of privately owned timber.

[2] According to recent checks this figure should be increased to almost 17 million.

[3] Forest purchase units are areas established by the National Forest Reservation Commission, in which Federal purchase of forest lands is authorized under the Weeks Act of March 1, 1911 (36 Stat. 961) and under the Clarke-McNary Act of June 7, 1924.

Fire protection, controlled cutting, planting, and range management have materially improved watershed services on the headwaters of almost all the major and most of the minor western rivers and many of the most important eastern rivers. The 81 million acres of range land in the western national forests has been built up steadily under management plans which now cover nearly the entire area. The national forests afford an unsurpassed opportunity to work out wildlife management integrated with that of timber, range, and other resources.

Recreation is the most concrete service which the national forests can render directly to millions of people. With requisite facilities and administration, this use can be greatly increased.

Present and Potential Timber Resources

The measures needed to put the forests on a satisfactory basis depend, to a large extent, upon the volume, character, location, ownership, economic availability, rate of cut or destruction, and rate of growth of the timber on the commercial forest land.

Volume, Character, and Location of Present Timber Supplies

Saw Timber.—Timber large enough for sawing into lumber and for most other commercial timber products is classed as saw timber. The total supply of saw timber is about 1,760 billion board feet (table 5).

TABLE 5.—*Stand of saw timber in the United States, 1938* [1]

[In billion board feet]

Region	Total	Softwoods			Hardwoods		
		Total	Old growth	Second growth	Total	Old growth	Second growth
Northeast	84.0	41.0	19.1	21.9	43.0	10.5	32.5
Central	14.3	.4	.1	.3	13.9	1.4	12.5
Lake	57.6	20.9	11.8	9.1	36.7	20.4	16.3
South	386.6	214.6	54.8	159.8	172.0	78.6	93.4
Columbia River Basin	882.6	877.7	749.1	128.6	4.9		4.9
Californa	213.5	213.5	206.5	7.0			
Southern Rocky Mountain	125.0	125.0	114.8	10.2			
Plains [2]							
Total	1,763.6	1,493.1	1,156.2	336.9	270.5	110.9	159.6

[1] Exclusive of Alaska, Puerto Rico, and Hawaii.
[2] Only a small quantity of timber in the Plains region is classed as saw timber.

Softwoods, such as pine, spruce, fir, and hemlock, comprise nearly 1,500 billion board feet, or 85 percent of the saw timber. Douglas fir with 490 billion feet, 80 percent of which is in Oregon and Washington, is far in the lead. Ponderosa pine, widely distributed through the West, is second, with 225 billion. Then come the southern yellow pines, western "true" firs, and western hemlock, with 197, 122, and 116 billion board feet, respectively.

Hardwoods make up only 15 percent (271 billion feet) of the saw-timber stand. Oak leads with 84 billion feet. The hardwood stand is practically confined to the East; two-thirds of it is south of the Ohio and Potomac Rivers.

Three-fourths of the softwood and two-fifths of the hardwood saw timber is old growth or mature timber—characteristically 200 to 300 years old or even older. This still dominates the market, although the cut of second-growth timber is increasing. Second-growth timber furnishes mostly rather low-grade products. Most of it should be left to grow into larger and more valuable material. The supply of second-growth saw timber is far too small to insure a sustained output after the old growth is cut.

The remaining saw timber is not well distributed in relation to the commercial forest land. The East, with three-fourths of the land, has less than one-fifth of the softwood and less than one-third of all the saw timber. Western Oregon, Washington, and California, with only 8 percent of the land, have almost half of the saw timber, including 60 percent of the old-growth softwoods. Nearly nine-tenths of the old-growth saw timber is in Rocky Mountain and Pacific Coast States.

Under orderly utilization this western supply would help to tide over the interval that must elapse before the East can be put on a satisfactory timber-growing basis. Current liquidation policies of most private timber owners in the West, on the other hand, tend to render systematic timber growing unprofitable for eastern owners.

Veneer logs.—Timber suitable for the production of high-grade veneers is becoming increasingly scarce. In the North, some veneer logs are obtained from second-growth stands, but large hardwood logs practically clear of defects, from which high-grade veneers are customarily produced, are obtained mainly from old-growth stands. The hardwood veneer industry now obtains much of its raw material from the South. The West leads in the production of softwood veneers. The large, old-growth timber of the West is especially well adapted to this use. Douglas-fir leads all other softwoods for veneers and is second only to red gum in total quantity consumed.

Cordwood.—There is about 1,850 million cords of wood in small trees too small for saw timber, and about 600 million cords in the tops and limbs of saw-timber trees. The volume is almost equally divided between hardwoods and softwoods. Two-thirds of the cordwood is in the East.

Except for the tops and limbs of saw-timber trees, which should be utilized up to the measure of feasible and economical woods practice, the great bulk of the cordwood is hardly available for cutting. Under good

forestry practice, cordwood-size trees would ordinarily be regarded as growing stock and left to grow into the saw timber that will be needed 30 to 70 years from now. The cutting of such trees should be limited to thinning or other stand-improvement work, or to stands managed primarily for such products as fence posts, pulpwood, and fuel wood.

Pulpwood.—There is a huge supply of timber that would yield satisfactory pulp, especially in the Pacific Northwest and the South; all told, it is several hundred times the annual pulpwood cut. But a large part of the supply of the species now used in pulp and paper manufacture will be utilized for other products, such as lumber, and will not be available for pulp. A considerable part of the volume of small trees, also, is not immediately available because, as explained above, these will have to be left for growing stock. With technical progress, and with improved forestry practices, on the other hand, there will be opportunities for greatly expanding the use for pulp for species now little used, and of material such as that now wasted in logging and sawmilling.

Ownership of Timber Supplies

The character of ownership of the timber as well as of the land is a primary factor in our forest situation. It influences the time and rapidity of cutting, and the organization of operations for sustained production. It influences the measures taken before, during, and after cutting to insure the establishment of new stands. It also affects the consideration given to dependent industries and communities.

This is particularly true of saw timber. The national requirements for forest products will best be met if programs of forestry are based on saw timber as the major object of management and if sufficiently long rotations are used to produce timber of considerable size and good quality. This has been the experience of every country where forest management has been substituted for forest liquidation.

Table 6 shows how the saw timber is distributed among the various classes of owners. Public agencies own or control about 42 percent of the total supply, including a large proportion of the relatively inaccessible timber in the West. They own only 6 percent of the saw timber in the East. There is 221 billion board feet of saw timber in farm woodlands, mostly east of the Plains. Relatively accessible and of better-than-average timber-growing capacity, the farm woods include almost 40 percent of the forest land and 40 percent of the saw timber in the East.

Industrial and other nonfarmer owners hold the largest acreage of forest land and the largest volume of saw timber. In general, their land is potentially more productive and their timber more accessible than that in public ownership. They supply fully two-thirds of the national saw timber cut. Less than one-fifth of their land but 60 percent of their timber is in the West.

TABLE 6.—*Ownership of saw timber, 1938*

[In billion board feet]

Region	Total	Public			Private		
		National forest	Other Federal	State and local	Total	Farm	Other
Northeast	84.0	1.6	0.1	1.3	81.0	19.9	61.1
Central	14.3	.3	.1	.1	13.8	10.1	3.7
Lake	57.6	3.9	1.3	5.7	46.7	13.9	32.8
South	386.6	13.5	1.7	1.3	370.1	161.1	209.0
Columbia River Basin	882.6	360.6	90.5	49.0	382.5	13.5	369.0
California	213.5	85.4	2.9	.8	124.4	2.8	121.6
Southern Rocky Mountain	125.0	100.3	15.1	1.4	8.2	.1	8.1
Plains [1]	(2)	(2)					
Total	1,763.6	565.6	[3] 111.7	59.6	1,026.7	221.4	805.3

[1] Most of woodland in Plains region is classed as noncommercial, though there is a considerable volume of timber.
[2] Less than 50 million feet.
[3] Includes 50 billion board feet on the O. and C. lands under the administration of the General Land Office, Department of the Interior, and 35 billion board feet on Indian lands under the jurisdiction of the Office of Indian Affairs, Department of the Interior.

Availability of Timber Supply.

The estimates of timber stand presented above do not measure the quantity available for cutting, for two reasons. First, most of the cordwood and younger saw timber should be retained as growing stock. Growing stock, together with the land, makes up the forest capital upon which sustained yield or forest "interest" must be based. Second, an appreciable portion of the timber at present is economically unavailable—cannot be cut profitably—because of its size and quality, the proportion of inferior species, the difficulty and high cost of logging, and remoteness from established transportation facilities and markets, or for other reasons.

It is estimated that about two-thirds of the saw timber in the United States could be cut profitably, by reasonably efficient operators, under present or recent operating and market conditions. In the West, where much of the saw timber is high up in the mountains, about half is economically available now. Improvements in logging and milling practices, and changing economic conditions, will undoubtedly push back the limits of economic availability, but considerable volumes may never be utilized. Possibly 90 percent of the saw timber in the East is economically available.

Forest Drain and Timber Growth

Any appraisal of the adequacy of our timber supply will have to take account not only of the volume of available standing timber but also the rate at which it is being used up. This is the difference between the annual drain—the volume of material removed from

the forests by cutting and that killed or destroyed by fire, insects, disease, wind, and other destructive agencies—and the annual growth.

Forest Drain.—In 1936, a year in which economic activity was still considerably below the predepression level, the total drain on our timber supply was 13.5 billion cubic feet (table 7). Seventy percent of this, equivalent to 47.8 billion board feet, was saw timber. Cutting accounted for 85 percent of the total drain, and 89 percent of the saw-timber drain; destructive agencies for the rest. The included losses, however, are not a full measure of the damage to the forest; for example, they do not take account of the destruction of young growth, the retardation in growth of injured trees, or the depreciation in the productive capacity of the forest soil.

Although softwoods comprised some 75 percent of the saw-timber drain and 60 percent of the total drain, the relative rate of drain on the hardwood supply, in both saw timber and total volume, was about twice that for softwood.

Current Timber Growth.—The total current growth of timber is estimated at 11.4 billion cubic feet; saw-timber growth at 32 billion board feet, two-thirds of which is softwood. Nearly two-thirds of the saw-timber growth is in the South, principally in pine forests. Not all of the growth really counts. This total includes the growth on economically unavailable stands, as well as the growth of relatively inferior species, some of which may not be utilized. Probably not more than 9.6 billion cubic feet, including 27.5 billion board feet of saw timber, can be considered as effective growth of usable timber.

TABLE 7.—*Drain on commercial forests, 1936*

Item	All timber [1]			Saw timber [2]		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Million cu. ft.	*Million cu. ft.*	*Million cu. ft.*	*Billion bd. ft.*	*Billion bd. ft.*	*Billion bd. ft.*
Cut for use:						
Lumber	5,368	3,998	1,370	27.70	22.01	5.69
Fuel wood	3,619	1,219	2,400	6.40	3.12	3.28
Pulpwood	706	638	68	2.25	2.11	.14
Hewed ties	354	183	171	1.49	.88	.61
Fence posts	327	131	196	.63	.25	.38
Veneer logs	253	72	181	1.19	.41	.78
Round mine timbers	161	47	114	.15	.08	.07
Cooperage	149	61	88	.71	.34	.37
Shingles	109	108	1	.49	.49	----------
Other	354	153	201	1.43	.71	.72
Total	11,400	6,610	4,790	42.44	30.40	12.04
Killed—not used:						
By fire	862	589	273	1.39	1.20	.19
Other agencies	1,201	862	339	3.97	3.57	.40
Total	2,063	1,451	612	5.36	4.77	.59
Aggregate drain	13,463	8,061	5,402	47.80	35.17	12.63

[1] Expressed in terms of volume of round timber from which the various items were cut. This includes small trees as well as those of saw-timber size.
[2] Expressed in terms of the volume of lumber that could have been sawed from the trees, regardless of whether the actual product was lumber or something else.

Relation of Current Growth to Drain.—Although total current growth for the country as a whole approaches current drain, the situation is actually less favorable than the growth-drain comparisons of table 8 indicate. Not all of the growth can be utilized. Cutting, for the most part, takes the better trees, but much of the growth is on small, low-quality trees. Much of the drain is concentrated locally, so that the timber essential for many established industries is being rapidly exhausted.

The high ratios of drain to growth on the west coast are less significant than they would otherwise be because of the large volume of virgin timber, which would permit a certain excess of cutting if it were properly distributed. On the whole, however, the existing stand of economically available timber is insufficient to sustain the current rate of saw-timber drain. The saw-timber stands in the East have only about two-thirds of the volume needed to sustain an annual saw-timber drain even as large as that in 1936.

TABLE 8.—*Current annual timber growth and drain, 1936*

Region	All timber		Saw timber	
	Growth	Drain	Growth	Drain
	Million cu. ft.	*Million cu. ft.*	*Million bd. ft.*	*Million bd. ft.*
Northeast	1,260	1,370	2,625	2,468
Central	568	907	978	1,781
Lake	979	983	1,850	2,420
South	6,495	6,689	20,403	23,642
Columbia River Basin	1,634	2,849	5,247	14,264
California	155	501	414	2,649
Southern Rocky Mountain	196	164	516	584
Plains [1]	----------	----------	----------	----------
All regions	11,287	13,463	32,033	47,808

[1] Growth and drain in Plains region not estimated. Nearly all forest in the region has been classed as noncommerical, although it produces considerable timber for local use.

Timber Requirements

No one can say with assurance just how much wood we shall use at any future time—even within the next decade, and certainly not 50 or 100 years hence. Equally indeterminate is the amount of timber that we shall supply to other countries. Yet a sound program of forestry must aim to anticipate both future domestic requirements and foreign demands.

One factor that will influence the amount of timber we can consume or export is the timber supply. An abundance of timber of the desired kinds and quality, at low cost, would make for larger consumption. On the other hand, scarcity, poor quality, and high prices would make for less consumption. This is one reason why utilization of the great volume of inferior timber in our forests constitutes a difficult problem.

Another factor is the ability of people to purchase timber products. When incomes of farmers and industrial workers are low, their expenditures for hous-

ing and for many timber products are small. High incomes and high standards of living, on the other hand, would unquestionably make for greater consumption of timber. There are also great possibilities for developing new wood uses and products. Wood is still largely used, except for shaping by manufacture, in substantially the form in which nature produces it. But even so, many of our present uses of wood have developed within the last hundred years. Revolutionary changes in wood utilization may be expected in the future, particularly through chemical processes. These may result in a considerable increase in total consumption, although some present uses may decline.

Then there is good reason to believe that the United States may play a larger part than heretofore in world timber markets. The trend of wood consumption in most of the principal wood-consuming countries except the United States has been upward for a century. Meanwhile, few of these countries can permanently increase their own timber production, particularly of the softwoods that are most in demand. World markets may therefore take larger volumes of American timber, provided it is available and priced within the reach of foreign consumers.

Finally, the amount of American timber consumed will be influenced by the efficiency and aggressiveness with which all avenues for the utilization of wood are expanded. It is reasonable to believe that modern scientific methods applied to promoting the use of forest products, whether in present forms or as something entirely different, would increase consumption just as has been the case with other materials.

Table 9 summarizes what is believed to be a reasonable estimate of possible future consumption, exports, and other forest drain, looking ahead several decades. This estimate is based on an analysis of consumption trends and other factors that influence the use of wood in building and for pulp, heating, and other important uses. A margin was added to allow for new uses and export and as a measure of safety. Any reduction in losses by fire and other agencies that may result from a forestry program will increase this margin. The totals, 68 billion board feet of saw timber and 21.4 billion cubic feet of all timber, are not much larger than the corresponding figures for 20 to 30 years ago, when our population was much smaller and world timber requirements much less than now. Although it may seem large, one must remember that not all of the timber that is grown has to be cut; that in publicly owned forests the maintenance of forest cover, to protect watersheds and assure other benefits, may take precedence over timber use and that many decades will be required to put our forests in condition to yield permanently 21.4 billion cubic feet a year.

TABLE 9.—*Estimated future annual drain on American forests, 2000 A. D. and thereafter*

Use or drain	Saw timber[1]	All timber[2]
	Billion bd. ft.	*Million cu. ft.*
Domestic consumption:		
Lumber	30	6,000
Fuel wood	7	5,170
Pulpwood	7	2,500
Miscellaneous present uses	7	1,930
Total	51	15,600
Margin for new uses, for export, and for a safety factor	12	3,800
Total estimated cut	63	19,400
Losses, fire, insects, disease, etc	5	2,000
All agencies	68	21,400

[1] In terms of sawed-lumber equivalent.
[2] In terms of round timber.

A Plan of Timber Management

The sustained-yield objective proposed in the preceding paragraphs is greatly in excess of current growth. A substantial advance in forestry is requisite to attain that objective. It can be attained by intensive management of part of our commercial forest land and less intensive management of the rest.

Any practical concept of management designed to balance future yields with probable timber needs must recognize that the intensity of management of a given tract will be influenced by many economic and physical factors. The more productive and better situated lands will be managed the more intensively. The poor and remote lands may deserve little more than protection. An intermediate category will be suitable for an extensive form of management.

A plan of management that would bring timber yields and requirements into balance is summarized in table 10. This plan, which is of course somewhat theoretical and flexible, would ultimately provide a sustained annual yield of 21.4 billion cubic feet, including 68 billion board feet of saw timber.

TABLE 10.—*A suggested plan of management to bring timber yields and requirements into balance*

Type of management	Area	Total annual yield
	Million acres	*Million cubic feet*
Intensive forestry [1]	100.0	8,400
Extensive forestry [2]	311.7	13,000
Simple protection [3]	50.0	0
Total	461.7	21,400

[1] Involves high standards of protection and silvicultural practice, so that the quantity and quality of the yield will approach the productive capacity of the land.
[2] Involves adequate fire protection and such silvicultural measures as are necessary to maintain growth in sufficient quantity for commercial utilization.
[3] Involves reasonably good protection against fire and overgrazing and, in some instances, reforestation or other revegetation where necessary to establish a protective cover. None of the estimated 370 million cubic feet of growth is considered to be economically available.

To attain such an objective in 75 years would require an increase in area under intensive forestry of more than a million acres a year. It would mean a

great expansion in the area under extensive forestry. The growing stock in the East would have to be doubled. In the West the remaining timber would have to be carefully husbanded so that cutting could proceed on a sustained-yield basis.

Forestry and Employment

It has been estimated that in 1936 the equivalent of nearly 3.8 million man-years of employment resulted directly and indirectly from the forest resource (table 11). Direct employment includes persons engaged in growing, protecting, harvesting, and primary manufacturing of forest products, and those in corresponding activities for other constituents of the forest resource. Indirect employment includes those engaged in the further manufacture of wood into finished products, in transportation, distribution, and building construction and in corresponding activities for other constituent resources.

If the forest-management program proposed above could be carried out, the ultimate possibilities for direct and indirect employment would, it is estimated, be increased to the equivalent of more than 6.3 million man-years. The greater part of the increase would depend upon the availability of markets to permit harvesting and manufacture of forest products.

TABLE 11.—*Forest-resouree employment in the United States in man-years, 1936*

Resouree	Direct employment	Indirect employment	Total
Forest produets	1,392,500	1,937,500	3,330,000
Forest ranges	196,000	27,000	223,000
Forest wildlife	23,000		23,000
Forest watersheds	13,500		13,500
Forest recreation	125,000	70,000	195,000
All	1,750,000	2,034,500	3,784,500

Perhaps even more significant than numbers of persons employed is the fact that sustained-yield forest management will facilitate the establishment, in or near the forests, of permanent communities, based upon wood-using and other forests industries. No longer will such industries have to pursue a retreating timber supply or will the forest communities be left stranded, without a source of livelihood.

The foregoing estimates relate to regular or recurrent employment. In addition to this, a large additional reservoir of work exists in connection with nonrecurring capital expenditures for various phases of forest restoration, protection, and management. This work, to a considerable extent, can be done at times when regular employment is slack and jobs are needed; it is related closely to the public-works programs set forth in the later chapters of this report.

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3. FACTORS, METHODS, AND PROBLEMS IN EVALUATING FORESTRY ACTIVITIES

Objectives of Forest-land-use Program

The general objective of a national program of forest-land use is to bring about such use of the Nation's forest land that it will meet current and future needs for forest products and services. Forest products include timber, forage, and other products of the land. Services include protection of soil and water, scenic and recreational values, protection against harshness of climate, provision of habitats for wildlife, and other contributions to the public health and welfare.

Attainment of this objective does not require, nor would it be economically justifiable to seek, maximum timber production from all forest land. Analysis of our forest situation and probable requirements, discussed in the preceding section, indicates that the objective, so far as timber products are concerned, can be attained with an ample margin of safety if a portion of our commercial forest land is managed intensively and the rest not so intensively.

Management for timber production will generally safeguard the other services and benefits of the forests that are so managed. It will be necessary also to maintain forest cover on forest land that is not managed primarily for timber production. This can be accomplished mainly through protection against fire and overgrazing. On some of these lands a certain amount of reforestation, other restoration of vegetative cover, or "upstream" engineering treatment of the land may be needed also, in order to regulate run-off, stabilize soil, provide forage and game cover, or increase recreational and scenic values. Such lands will, of course, require roads, trails, and physical facilities for administration and use.

Public Works and Related Activities Required to Effectuate the Forest-Land-Use Program

Effectuation of a forest-land-use program involves several lines of public and private action. It will require much intensive research—biological, technological, and economic—to develop methods of production and utilization. It will require a broad program of education of forest-land owners, users of forest products, and the public at large, to instruct them in methods of production and use and to gain their support for a land-use program. It will require the training and employment of technical and administrative staffs to manage public and private forests, and the organization of a competent labor force to work on the land and in the plants that process forest materials. It will require institutional adjustments and devices, partly through legislation, to facilitate and stimulate good forest-land management. It will require more systematic adjustment and stabilization of forest-land ownership than can be brought about by the hit-or-miss process of tax delinquency and land abandonment.

It will require also an extensive program of works, designed to build up and equip the physical plant of the forest enterprise. These works may be grouped in at least four broad classes, namely: (1) Protection of the forest resources from destruction; (2) rehabilitation and development of the resources; (3) construction of facilities required for administration and management; (4) construction of facilities required for utilization. Some facilities, such as roads, serve all four of these purposes.

When these activities are carried out on land owned by the Federal, State, or local governments, they clearly fall within the field of public works. But public forestry projects need not be confined to publicly owned land. The public interest in conservation and development of our forest resources, regardless of their ownership, has long been recognized. For many years, Government has shared in the cost of protecting privately owned forests from fire and other destructive agencies. Federal and State Governments have subsidized forest planting, mainly on farm lands. Within the last few years governmental agencies have advanced funds for the construction of privately owned timber-processing plants. A long-time, over-all program of forest development may well contemplate much greater public participation in works on private lands, both through outright expenditures and through advance of funds that eventually will be repaid.

At the same time, although not "works" in the narrow sense of the word, public acquisition of forest land is an essential part of a program of forestry and of public works in the field of forest-land use. Governmental assistance to private owners will not in all cases insure that the desirable programs will be carried out. Ownership of the land will in many instances be necessary to facilitate the undertaking of works projects by public agencies, to insure continuity and stability of management, and to give the public sufficient control over the land to insure that the anticipated benefits will be realized.

The present report deals primarily with a program of works connected with the handling of forest land for tree production, both for use as timber and for the other benefits of forest cover, and with over-all activities such as protection, transportation facilities, and administrative facilities which apply to both commercial and noncommercial forest land.

Most of the works activities covered in this report also serve to protect watersheds, stabilize the soil, to provide forage for domestic livestock and habitat for many forms of wildlife, and to improve recreational facilities. These purposes, therefore, must be considered along with the timber-management objectives when evaluating projects. Specialized activities in these fields, covering forest as well as nonforest land, are dealt with in the range, recreation, and wildlife reports and are not covered here.

Formation of a Forest-Works Program

Ultimate Goal

The ultimate goal of a public-works program in forest-land use, as in other fields, is to maintain and increase the national well-being through production of goods and services. This can be accomplished in the long run only through protecting, developing, and expanding the natural resource base from which goods are derived and upon which many services are dependent.

The extent to which such development and expansion of our forest resources will be justifiable depends fundamentally on the nature and extent of our future need for forest products and services. Our need for forest products, on the other hand, will be influenced by the degree to which the abundance and low price of such products enable our own people and our foreign customers to buy them, and by the success of research in discovering new and better ways of using them.

The goal of the program is not primarily to make jobs, although the creation of jobs may be a deciding factor in the timing and location of specific projects. In other words, a project cannot be justified merely by the fact that it will give employment, but it must be worth doing as a part of the over-all program of building up and maintaining our resources. This principle has been well stated in the following words: "The richness of our domain does not free us from the responsibility of devoting our time and our energies to making right things, lest we waste our substance in making wrong things. Thus, we have the resources for using all our unemployed workers in the construction of pyramids, but we would scarcely call the decision to do so one of social intelligence. Public works construction is a means toward an end rather than an end in itself. Great though the process values may be in providing jobs in a period of economic strain, the primary aim of the process must be a product that will contribute to the development of the Nation." [1]

Nor is the gaining of direct income for the public treasury a major objective of the program. Except under a system of State capitalism, public works are seldom, if ever, undertaken primarily to earn a profit. Other public values and benefits generally have much greater weight in determining whether a given program or project should be undertaken. But the possibility that it will be "self-liquidating" may be an important factor in deciding whether government should finance a project. This will be particularly true where the government is asked to advance funds to expedite programs for which private beneficiaries or local units of government should eventually pay a large share.

Relation of Benefits to Costs

The basic criterion for evaluating a program or a specific project is the relation of benefits to costs. All benefits and all costs must be considered, regardless of whether enjoyed or incurred by individuals or by the public at large.

Costs (including associated disutilities) are ordinarily computed and expressed in monetary terms, in money or its equivalent. Their determination for a given program is a specific technical problem in the field concerned. If all benefits could also be expressed in money, it would be possible to reduce both benefits and costs to the same point in time, and to express the relation of benefits to costs by a ratio which would be comparable with similarly determined ratios for any number of projects in as wide a variety of fields as might be desired. In spite of the obvious advantages of a monetary common denominator, it is clear that there are difficulties in the way of its use.

Benefits of forestry projects consist only in part of goods and services that are commonly bought and sold and which therefore can be appraised in the market sense. They consist also of indirect and nonvendible returns which are difficult to appraise objectively because recognized guide posts like market prices are wanting. In absence of monetary expression of these returns, however, it is necessary to fall back on word pictures for setting up priorities in public works. The mind can retain and compare only a few such word pictures at one time. In such case, the choice among projects competing for a limited fund tends to represent the personal predilection of those in authority, influenced by the showmanship of the sponsors. Therefore the development of reasonable methods of evaluating the

[1] National Resources Planning Board. "Development of Resources and Stabilization of Employment in the United States. Part I. The Federal Program for National Development." January 1941, pp. 4 and 23.

nonvendible returns from forestry undertakings is of great importance to the intelligent planning of public works in this field.

In referring to the evaluation of benefits in monetary terms for the purpose of arriving at a benefit-cost ratio, it is not intended to imply that such a ratio can be established irrespective of the scope of the project, or the limits to which it may be carried. Execution of the most urgent projects in any field would reduce the value of more benefits from additional projects of the same type—i. e., would reduce the margin of benefits over costs. Eventually, of course, a point would be reached beyond which added projects would give a benefit-cost ratio less than unity—i. e., the cost increments would exceed the corresponding benefit increments. There may be social justification for any works project (considered apart from alternative projects) which yields benefits with a social value slightly in excess of one dollar in return for the last dollar of cost incurred.

This concept of cost-benefit ratio as related to the marginal unit of cost is also of great importance as a means of arriving at comparative valuations for works projects of different types. From the standpoint of society, the ideal arrangement would be achieved when the cost-benefit ratio was identical for the marginal dollars expended on every class of project. If such a marginal equilibrium were attained, the investment in public works—no matter how large or small it might be in the aggregate—would provide the greatest possible total of social benefits. Theoretical techniques can be developed for defining this marginal equilibrium but a great deal of work will have to be done to make them practicably applicable to the problems in hand. In the meantime, a common-sense approach (with regard for the principles which have been outlined) will permit a rough determination of priorities and provide a reservoir of urgently needed projects sufficient for execution in the near future.

In the last analysis, it may be assumed that once a specific forestry program for a given area has been determined to be necessary for the public welfare, any reasonable project or group of projects essential to its effectuation will be justified. For example, if it is decided that a given watershed should be kept in forest in order to supply local needs for timber and water, prevent damage from floods, and provide recreation, any expenditures necessary for the requisite forest planting and forest protection should be approved.

Intensity of Management

The character and volume of work that can be justified on a given area will depend upon how intensively the area needs to be managed in order to provide the goods and services that the public interest demands. It has been pointed out above that only a portion of our forest land will need to be managed intensively in order to meet our wood requirements, and that protection alone will suffice for some areas.

The degree of intensity of use should be adjusted to regional and local needs and potentialities, as determined by physical, biological, economic, and social factors. For example, factors favoring intensive use include easy accessibility, high productivity of sites, high proportion of valuable tree species, reasonably adequate growing stock, fairly slight danger of loss from fire or other agencies, good local demand for a variety of timber products (including low-grade material), stable ownership in units suitable for sustained-yield management, adequate resident supply of competent workers, and public sentiment favorable to a forest economy. Where the opposite conditions prevail, extensive management or simple protection may be all that can be justified. Intensive silvicultural measures will generally be confined to areas where production of timber is a major objective. Mere protection and maintenance of forest cover, together with such improvements as are needed for administration and use, will suffice to insure most of the other benefits of forest cover.

Requirements of a Forest-Works Program

Orderly Sequence of Activities.—A program for the protection, development, management, and utilization of the forest resource involves a wide variety of works projects and other activities. To a considerable extent, activities on a given area must follow a definite sequence. For example, in many areas the first step might be acquisition of the land. Then roads and trails would be built to make the area accessible and facilitate administration. At the same time, lookout towers and telephone lines and firebreaks would be built as part of the program of fire protection. Nurseries would be established and seedlings grown, which would then be used to plant up vacant lands. After a few years, weeding and thinning and improvement cutting would be done in the plantations, and similar operations would be necessary in the natural stands. As the forest became older, timber utilization roads would be built, and sawmills and other plants to process the timber would be established. At the same time, projects connected with other uses of the forest might be undertaken, such as range improvements, soil conservation measures, stream improvement, development of water supplies, and provision of recreation facilities.

Continuity.—The development, once started, must be continuous and progressive. Some phases of it can be held in reserve to provide employment in dull times, but many operations cannot be handled on an irregular, intermittent basis. For example, fire protection has to

be provided every year, beginning as soon as the forest is put under management. Plants grown in the nursery have to be planted as soon as they reach the proper size, and after the plantations are set out they cannot be neglected without serious economic loss. Administration and protection of the forest will require at least a skeleton system of roads and trails from the outset.

Provision for Recurrent Activities.—For administrative and technical reasons, the forestry program and its attendant program of public works will have to start on a relatively modest scale and be built up progressively. Eventually the curve of expenditures for nonrecurrent work will reach a peak and thereafter decline, while the curves of recurrent, normal expenditures and employment will gradually rise, until the forests are fully developed on a sustained-yield basis.

Any program must take into account the necessity of maintaining structures and other improvements after they have been constructed. Forest roads and trails and telephone lines go to pieces quickly if not kept up. Buildings and lookout towers must be kept in repair. Firebreaks must be kept clean of inflammable material. The maintenance job tends to grow from year to year, as more improvements are completed. It is a recurrent job, which requires regular funds and provides regular employment. It would not be good management to neglect maintenance work during some years in order to create a job reserve for other years.

Long-Term Program Essential.—Some benefits from forestry projects may be realized immediately; others will be deferred for many years. The biological as well as the economic limitations upon forest management and timber production are such that a forestry program must be a long-range program. Even if the program that has been suggested could be got under way on an adequate scale and carried forward without interruption, it could hardly reach the goal of sustained timber production that appears desirable within less than 75 years. It is obvious that a program of forest development involving so many different sorts of work, spread over a long period of years, must be based on a definite long-term plan if it is to be effective and avoid undue waste of effort and funds.

Surveys and Research Fundamental.—The basis for complete detailed plans is not yet available, and will not be for many years. No plan can be final in all its details. Conditions change from year to year, and our knowledge of the underlying factors and of the technics of forest management should improve as time goes on. It is for this reason that continuing expenditures for surveys and research in all branches of forestry are an essential part of a sound forestry program.

Regional Balance.—Ordinarily, a program of forest-land-use activities should be kept in balance among the various forest regions and within each region, with due regard for the forest situation and the social and economic needs in each, and for the relation of each region to the national situation. Work should not be concentrated unduly in some regions or areas while others are neglected. The aim within each region and local area should be to maintain the forest resource in a condition so that it will contribute most effectively to the needs of the local people, within the framework of the national forestry program.

Unified Direction.—In view of the multiple-purpose objectives of forest-land use, it is important that all works activities on any given area of forest land be under the control of a single agency. Only in this way will it be possible to obtain satisfactory coordination among the various lines of work, each of which affects all of the others.

Coordination With Other Land-Use Programs.—Furthermore, a program of forest-land use should be coordinated with programs in other land-use and related fields. Programs for range use, recreation, and wildlife management cover forest as well as nonforest land and, where forest land is involved, must be integrated with the over-all forestry program. As a major objective of forest-land management is to conserve water resources and check soil erosion, the forestry program is intimately related to programs for navigation, irrigation, hydroelectric power, and other uses of water. Forestry is complementary to crop and livestock raising in most forested sections of the country, so the forestry program cannot be developed without regard to agricultural programs, such as resettlement, cropland retirement, and rural rehabilitation.

Characteristics of Forestry Work

Forestry activities are particularly well adapted for providing employment for rural people. Since work of one sort or another needs to be done on all of our forest land, opportunities for jobs are offered in almost any rural locality where they may be needed, without necessitating migration of the workers. Moreover, the greatest volume of forestry work is required in the areas where rural incomes are the lowest and where there is greatest need for employment.

Forestry work can readily be arranged to supplement farm work. It requires similar skills and ability, and a large proportion of manual labor. In much of it, the farmer can use his horses or other work stock. Much of it is seasonal, and can be done at times that will fit in with part-time or seasonal farming. As many operations recur from year to year or are repeated at short intervals, a managed forest can be depended on for jobs to supplement the incomes of rural people. Many jobs can be done by men working individually or in small

groups; others are best accomplished by large crews. In many localities work in the woods is so close to farms and villages that workers can live at home.

Many kinds of forestry work are highly flexible, in that they may be started on relatively short notice (provided plans have been made in advance) and may be suspended or stopped as quickly, without sacrifice of the work already done. This will be especially true as long as there remain large areas of unmanaged forest to be organized and developed—which promises to be the case for many years.

An especially significant characteristic of forestry projects is that they not only give immediate employment, but also help to build up a resource that will give many more jobs in later years. Harvesting, primary and secondary manufacturing, and transporting of timber products from managed forests will provide direct work for several times as many persons as are employed in protecting, developing, and caring for the forests. Utilization of the forage, water, wildlife, and recreation values will give work to many others.

Selection of Projects

A program of public works connected with forest-land use, at least in general outline, can and should be planned for a long time ahead, with due provision for amending it as new conditions arise and local situations develop. Such a program will include a great many more projects than can be undertaken at once. For any given time and place, choice will have to be made among the many desirable projects. This choice involves not only a decision as to the kinds of work to be done, but also decision as to where it will be done and when it will be done in each region or locality.

In formulating programs for immediate action—as for a year or a short period of years, priorities will have to be set up among regions and locally within regions, and among lines of work within each. Priorities and criteria for determining them will depend on local conditions and on the general economic situation at the time decisions are made. During periods of severe unemployment, for example, projects that will provide a lot of jobs will have high priority; at other times they may be held back, except where necessary to carry out an orderly program; at another time and place, considerations of national defense might be the determining factor. In yet another place, the fact that certain work must be done now in order to insure the permanence of an industrial plant and its dependent community might be decisive.

Some of the general criteria that should be considered in evaluating and selecting projects are given below. They are all more or less interrelated, but for convenience are listed in three groups: (a) Criteria of value of project (Is it worth doing?); (b) criteria in timing projects; (c) criteria for selecting location of projects.

Evaluation Criteria

There are certain qualifications that should be considered essential, so that failure to fulfill any of them would require disapproval of the project. The first six items in the list below are such criteria. Certain of the other qualifications listed should generally be met, but under some circumstances projects failing to do so may be approved. Items 7 to 10 fall in this class.

The rest of the list under this heading includes criteria (items 11 and 12) to be considered in choosing among projects that meet the preceding requirements, as well as certain criteria that may have greater weight at some times than at others (items 13, 14, 15), or that apply only to certain types of projects (items 16 and 17).

1. Is the project essential to and in conformity with the forestry-activity program that has been set up as a goal—national, regional, and local?

If so, this would constitute a strong presumption in its favor.

2. Will the total of expected benefits be greater than the total costs, including nonmonetary values of both? And will the expected benefits to the public exceed the costs to the public?

Benefits and costs, both direct and indirect, should be expressed in terms of dollars so far as practical to do so. Benefits or costs that cannot be so expressed should be described in sufficient detail to enable the evaluating body to form its own subjective judgment as to how much weight should be given to them in considering the project.

3. Is it technically sound and backed by adequate investigation and scientific research?

This question would apply to methods of doing the job and probable results in terms of products and benefits. For example, a proposed project for large-scale planting in the California foothills or the Great Plains should be supported by assurance that methods of establishing plantations in those areas at reasonable cost have been worked out.

4. If the job is undertaken, is there assurance that it will be finished, together with further measures that may be essential?

For example, it would be foolish to establish nurseries and raise planting stock without reasonable assurance that the trees would be planted after they are grown.

5. Are qualified supervisory and technical personnel and adequate equipment available for doing the job?

6. Is there reasonable certainty that provision will be made for maintenance or upkeep after the work is done?

7. Is it consistent with the forestry programs of other public agencies working in the same region?

Obviously, the programs of all agencies should be reasonably consistent, or at least should not interfere with or nullify each other. However, the fact that a project is not consistent with programs of other agencies does not necessarily mean that it should not be undertaken. It may be that those programs should be modified.

8. Is it consistent with programs in other fields of land use, or in related fields?

The fact that a program of forest development would supplement a program of agricultural adjustment or submarginal-land retirement should have considerable weight.

9. Is it in reasonable balance with other types of forestry work, locally and nationally?

For example, it would not be desirable to concentrate efforts too largely on one line of work, such as forest planting, and to neglect other lines.

10. Will the project compete with and tend to discourage private enterprise, or will it supplement and stimulate private enterprise and employment?

Many public forestry projects will lead to the investment of private capital in processing plants and other enterprises which will enable many persons to earn a living. The probability that private economy will be stimulated by a given public expenditure for forestry should have considerable weight in selecting projects.

11. Is it likely to create other jobs now or later, besides the direct employment that it will give, and to what extent?

Other things being equal, projects that will thus provide additional indirect employment should be preferred to those that will not.

12. Is it likely to result in permanent benefits and a permanent forest economy, or only in temporary, short-term benefits?

13. Can it be started and suspended or stopped quickly without waste and loss of work already done, and without serious disruption of the program as a whole?

Such projects are especially suitable to be kept in reserve until needed to help smooth out depressions in the curve of employment.

14. How many persons will obtain employment or otherwise derive direct benefit from the project?

15. Will it contribute significantly to national defense?

16. If the work is to be done on private land, is it work that the owners themselves will not or cannot do?

17. If it is a case of the public advancing funds for a private enterprise, or of loans by one agency of Government to another, what are the prospects that the advance will be repaid (self-liquidating) and how soon?

Criteria for Timing Projects.—1. Should the work be done now as an essential follow-up of work already done, or as a prerequisite of work to be done?

For example, if nursery stock has been grown to the proper size for field planting, a planting project is in order, or if the program calls for planting a given area within the next few years, production of the stock will have to be undertaken first.

2. Is the forest in such condition, or at such a stage in its development as to require that the work be done now?

3. Will the benefits result soon, or will they be long deferred?

Other things being equal, it may be desirable in certain areas to give priority to projects that will result in early benefits. For example, under certain conditions improvement of partly grown stands that will yield timber within 20 years should be undertaken before planting new stands that will yield none for 60 years or more.

4. Will the work cost much less now than if it is deferred for a few years?

5. Are jobs of the kinds to be provided by the project needed now?

6. Is there an emergency that requires the work to be done now—to prevent loss of lives or property, or to repair or prevent damage that will seriously disrupt the rest of the forestry program?

Preservation of values already existing will generally have priority over the creation of new values. For example, reduction of extreme fire hazard in the New England hurricane area would take precedence over forest planting in the same area.

7. Should the work be done now in order to keep trained personnel and specialized equipment employed?

For efficient conduct of many kinds of work, road construction, for example, a permanent organization is essential, and it should be kept employed on the kind of work that it can do best.

Criteria for Locating Projects.—1. Is the program in balance regionally, and within each region?

It would not be desirable, for example, to concentrate all forest planting in one region, or all road construction in a single State.

2. Will the project benefit existing industries and communities?

Commonly, these should take precedence over industries and communities that may be established in the future.

3. Are jobs of the kind to be provided by the project needed in the locality in question?

This involves the matter of "problem areas," where a considerable population is largely dependent upon

the forest, and where large-scale public action will be necessary to insure that the forests will continue to provide jobs.

4. Is there a critical forest situation requiring immediate attention in the area in question?

For example, high fire hazard that can be reduced by the proposed project, or a denuded area that will erode and silt up a reservoir if not reforested.

5. What assurance is there that the forest will continue to be handled in such a way that the expected public benefits will be realized? Is publicly owned land available upon which the work may be done?

The best assurance is through public ownership of the land. It is for this reason that large areas on which work needs to be done have been acquired by the public. Large public expenditures on private land may not be justified except where the public has a considerable degree of control over the way the land is used, either through agreement with the owners or through legislation.

6. Is the attitude of the people in the locality favorable or actively cooperative?

7. Is there enough work in the locality in question to justify undertaking the project?

This would apply particularly where a special overhead organization would be required, or where a crew of workers would have to be brought from a distance and camps set up.

The Public's Share in Cost of Forest-Works Program

On Public Lands

It is generally recognized that government—Federal, State, and local—should carry out and pay for most of the necessary works projects on lands that are permanently in public ownership. The Federal Government should be responsible for work on Federal lands. State and local governments should generally be primarily responsible for work on their lands, but where substantial national interests will be promoted by a project the Federal Government should share in the cost, through advance of funds or outright subsidy. In some instances, where the national benefits will greatly outweigh local benefits and where the States for financial or other reasons are unable to participate, the Federal Government may be justified in bearing the entire cost. Projects contributing substantially to the war effort or to protect navigation are examples.

There are some classes of construction work on public forest lands that are commonly, but not always, left to private enterprise, though, of course, subject to public regulation and approval. Examples are summer homes and resorts constructed and occupied under special-use permits or leases, and logging roads, camps, and railroads required for utilizing the timber. Construction of sawmills and other plants for shaping and processing public timber has been left almost entirely to private enterprise.

On Private Lands

For lands not now in public ownership, Government responsibility depends upon whether the owners can be depended upon to do what the public interest requires. If private interest coincides with the public interest so far that the owners will carry out the essential measures, no public participation will be necessary. This will seldom be the case. The private owners' interest is measured mainly by the income they get from the land. They are not likely to carry out intensive and costly measures to rehabilitate and develop, or even to protect, lands of low productivity or remote from markets, or lands that will yield no income for half a century or longer. They are even less likely to carry out works exclusively or mainly for the benefit of others, such as downstream water users or nonpaying seekers of recreation.

The public's interest in conservation and development of most forest land, on account of the indirect benefits involved, so far transcends or supplements the individual owners' interest that the public should pay part of the costs. This principle has been recognized in provisions for cooperative fire protection, control of forest insects and diseases, demonstration projects in farm woodland management, distribution of low-cost trees for planting, cooperation in establishing shelterbelts, and benefit payments for forest planting and woodland improvements. In general, public expenditures that exceed the total benefits to the public (as distinguished from private individuals or groups) will not be justifiable unless such excess can later be recovered from the private beneficiaries.

The public may often be justified in advancing capital to private enterprises to expedite programs that are in the public interest. Such advances should generally be on a self-liquidating basis. Examples are loans for construction of sawmills and pulp mills, in order to provide immediate employment and utilize idle or wasting resources; loans to forest owners to help them organize and develop sustained-yield units.

Expenditure or advance of public funds for forestry projects will seldom be justified unless the public has sufficient control over the use of the land to insure that the purposes of the expenditure will be realized. This may be done without disturbing the ownership of the land, through contracts with the owners or through regulatory legislation. For a substantial area, public acquisition of the land will be the best solution.

4. MAJOR FORESTRY ACTIVITIES IN THE PUBLIC WORKS FIELD

The following pages present a series of long-range programs of forestry activities, composed largely of nonrecurrent work. These are classified into several main groups in order to facilitate their consideration.

The programs presented concern the forest lands of the United States proper. For the sake of effectiveness and convenience, the case of Alaska is presented separately so as to combine those pertinent major activities which, for the United States proper, are treated under separate headings. The Shelterbelt Project has also been treated by itself, because of its specialized character and objectives.

In a broad sense, the over-all management of publicly owned forest lands could be considered as public works, and as time goes on perhaps it will tend more and more to be so considered. For purposes of this report, however, public works are envisaged mainly in the narrower sense of nonrecurrent construction, forest planting, forest-stand improvement, etc., with only a modicum of recurrent activities.

Effort has been made to minimize the overlaps between programs presented under the various activities. "Forest transportation facilities" include all such facilities, regardless of whether they serve one activity or use, or more than one. Transportation requirements for forest protection, for example, are included under transportation rather than under protection. "Protection of forests from fire" undertakes to cover only the facilities and structures that are needed primarily for forest protection. Those which serve several purposes, including general administrative use, are included under "forest improvements." If some of these forest-activity programs overlap others to a slight extent, or even other land-use programs, such as recreation, range, and wildlife, such duplication should not cause any difficulties in considering them separately.

The information needed for the formulation of long-range programs is not uniformly available or reliable for the several classes of owners, geographical areas, or lines of activity. Consequently, there is considerable variation in the assurance with which these programs may be accepted as proposed. The information and the plans for a large proportion of the Federal lands are more complete, and the programs set forth here for such lands can be considered more reliable, than those for State and private lands. They are not, however, rigid or inflexible programs. Forest conditions, as well as economic conditions influencing forest-land use, are dynamic, and any long-range forestry program is subject to constant development and reorientation. The public-works programs are drawn up mainly on the basis of existing division of forest land among public and private owners. If a shift in ownership takes place there will be a corresponding shift in the volume of work that should be done by public agencies.

Estimates of employment possibilities in the works programs naturally are subject to modification as conditions change and experience is gained. They are believed to be conservative in all cases. The "man-month" unit in which they are expressed is assumed to be 22 man-days of ordinary efficient labor. Tasks that are performed by inexperienced WPA, CCC, and other unskilled labor must be more loosely measured.

The sections on the basis for evaluation under the respective programs should be considered in conjunction with the more general treatment of evaluation in the preceding chapter.

The regions given in the program tabulations are those shown in figure 1.

Protection of Forests From Fire

What Fire Does to the Forest

Protection against forest fires is indispensable to the conservation of forest resources. With minor exceptions, fires may occur on all forest lands. The average area burned over annually for the period 1935–39 was 32 million acres, of which approximately 29 million acres was on State and private land not yet under organized protection. The average annual direct loss in timber values and physical improvements was more than $32,000,000.

High as these figures are, they do not cover the occasional conflagrations in which lack of adequate protection is especially serious. For example, the Minnesota forest fire of 1918 entirely destroyed Cloquet, a busy sawmill town of 12,000 people, cost seven lives and property and timber valued at $30,000,000. In 1933 the Tillamook fire in Oregon burned 267,000 acres and destroyed some 12 billion board feet of timber valued at $20,000,000.

In addition, there are indirect losses which, though difficult to appraise, are often more serious than the direct losses.

The increased attacks of forest insects and diseases are frequently induced by the weakened condition of

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the trees due to fire. A major indirect loss is the deterioration or destruction of the economy of many communities where the backlog of available timber has been destroyed. Under certain conditions, severe disruption of business and transportation and weakening of the national defense could result from extensive forest fires.

A fire that destroys the ground cover on slopes increases the surface run-off because there is no litter to retain the water or slow it up until it is absorbed by the soil. Under certain conditions, the beating of the rain upon the bare soil forms an "erosion pavement" by choking the soil interstices so that it is more difficult for water to penetrate. Thus, the cumulative effect often is rapid run-off—frequently floods—and at the same time a lowering of the normal water table. Burning of the ground cover often leads to serious erosion of the soil and silting up of reservoirs and irrigated lands.

Fire-Protection Activity—What It Is

Some degree of protection has been given to 74 percent of the total forest area that requires organized fire protection (table 12), but this protection is by no means adequate. Of the 152 million acres not now under organized protection, 98 percent is in private and State (including local government) ownership, and 77 percent is in the South. Some of this so-called "unprotected area" may be receiving unorganized but reasonably effective protection from the owner or tenant.

Forest fire protection involves many activities besides fire suppression. One of these is education of the people residing in or using forested areas to appreciate the effect of fire upon forest resources and the need for proper use of fire. This involves lectures, demonstrations, "show me" trips, personal contacts, motion pictures, and distribution of published material.

Satisfactory standards of fire suppression require preparedness in equipment, manpower, and organization. Equipment must be purchased and distributed; some is specialized and must even be designed and built by the using agency.

Training must be conducted regularly in order that all men in the fire-control organization fully understand their individual duties and responsibilities and how they fit into the organization as a whole in times of fire emergency. They should be fully trained in new technics and the operation of modern equipment.

Effective fire suppression depends largely upon carefully organized and coordinated attack—whether it involves the solitary "smoke-chaser" dispatched at the first alarm, the effective placement of crews of 30 or 40 men to respond to more urgent demands, or the organization without advance notice of an army of several thousand men to hold the line on a single fire.

TABLE 12.—*Forest areas needing protection from fire and those under organized systems of protection in the United States, exclusive of Alaska and Puerto Rico, as of January 1940* [1]

Region and ownership class	Needing fire protection	Having some organized protection	Without organized protection
	Million acres	*Million acres*	*Million acres*
Northeast:			
Federal	1.4	1.4	
State and private	59.3	57.8	1.5
Total	60.7	59.2	1.5
Central:			
Federal	1.5	1.5	
State and private	20.7	7.3	13.4
Total	22.2	8.8	13.4
Lake:			
Federal	6.6	6.6	
State and private	51.1	51.0	.1
Total	57.7	57.6	.1
South:			
Federal	11.8	11.8	
State and private	214.5	97.5	117.0
Total	226.3	109.3	117.0
Columbia River Basin:			
Federal	64.8	61.4	3.4
State and private	33.9	33.1	.8
Total	98.7	94.5	4.2
California:			
Federal	14.5	14.5	
State and private	25.1	23.4	1.7
Total	39.6	37.9	1.7
Southern Rocky Mountain:			
Federal	57.0	57.0	
State and private	20.6	6.3	14.3
Total	77.6	63.3	14.3
Total United States:			
Federal	157.6	154.3	3.4
State and private	425.2	276.4	148.8
Total [2]	582.8	430.7	152.2

[1] Based on U. S. Forest Service annual fire report, calendar year 1939. The areas needing protection do not agree with the total commercial and noncommercial forest areas of the several regions, shown elsewhere in this report, because the above areas exclude many scattered farm woodlands that do not need organized fire protection, and on the other hand include areas of nonforest land intermingled with forest lands that need protection.

[2] Above totals include less than 0.1 million acres in Plains region.

Prompt detection and rapid travel are as important as the suppression effort. Men in lookout towers detect fires and instantly report them to fire dispatchers by telephone or radio. Men and equipment are rushed by truck as far as possible, thence by foot to the fire line; sometimes airplanes are used for transportation to emergency landing fields. Where necessary men and equipment are parachuted directly to fires. In the suppression of the fire, men use tools and equipment ranging from shovels to complicated power-pump equipment. Wide firebreaks are sometimes cleared through the forest cover as a means of checking the progress of a fire and to afford a reasonably safe route to travel to the fire.

The bulk of the fire-protection personnel is usually employed seasonally, but its effectiveness requires a permanent organization, a "regular army," so to speak. The permanent organization does the long-time planning, furnishes administrative services, and forms the

framework about which a larger organization may be quickly built in critical seasons or to suppress large fires. Thus, fire protection is not an activity that appears when it is needed and then disappears entirely until it is again called forth. It requires a permanent nucleus which expands to meet current necessities. Besides administrative manpower, there must be physical facilities such as lookout towers, communication facilities, roads, trails, and firebreaks; and up-to-date suppression equipment must be provided. Involved also are public education, training, and preparation for fire fighting. The degree to which these activities lend themselves to public-works programs varies with the particular type of activity.

The Place for Public Works in the Fire-Protection Program

Several important factors make forest-fire-protection activities particularly suitable to a public-works approach. Most of the labor to be used may be unskilled. Only a minimum of technical supervision is required. Equipment and construction materials are relatively simple and inexpensive. Work opportunities for local people are afforded by the entire 630 million acres of forest lands.

Forest-protection programs and work projects are either recurrent or nonrecurrent in character. In a broad sense, both types of projects afford opportunities for public works, but most nonrecurrent fire-protection projects, such as the construction of fire towers, firebreaks, and truck trails, are more suitable than recurrent projects for advance planning. It is around such types of work that the proposed long-range public-works programs have been developed. Although recurrent types of work, such as maintenance and repair, could theoretically be included, it is better to care for such needs through the regular budgetary procedure as at present.

Major nonrecurrent projects that are unforeseeable will occasionally be necessary, and for those no advance plans can be made. An outstanding illustration is the New England Forest Emergency Project, which involved the reduction of the tremendous fire hazard caused by the 1938 hurricane. This project, covering 14 million acres of forest land in six States, employed approximately 227,000 man-months of WPA, CCC, and Forest Service labor. More than 21,000 local men were employed at the peak.

Construction of roads and trails for the transportation of men, equipment, and supplies offers one of the greatest single opportunities for public works in fire protection. These protection roads and trails are included in the program for forest transportation.

The fire-protection works program falls naturally into several categories, defined as follows:

Surveys and Plans.—Mapping of forest fuel types; fire-control transportation and communication planning and mapping; seen-area mapping to place lookouts for the most effective coverage.

Hazard Reduction.—Reduction of inflammable material along trails, roads, and railroads; snag felling; construction of firebreaks; fireproofing of camp grounds and recreation areas.

Improvements.—Construction of lookout towers and cabins, special telephone lines, airplane landing fields, fences (to protect forest areas from such fire hazards as tumble weeds), fire-crew barracks and headquarters, fire-equipment warehouses, radio stations, water holes, etc. Landing fields and fences and telephone lines other than the above are covered in the sections on forest improvements and forest transportation facilities.

Operation.—Purchase of equipment; training of new fire guards, lookouts, and special fire assistants; public education and preparation of fire exhibits; investigations of law-enforcement cases; fire studies.

Equipment is the main item of cost under this heading. At one time the purchase of equipment for fire-protection purposes would not have been considered to be a public-works expenditure. Such equipment makes more effective the use of manpower, rather than displacing it, and may be considered to extend the scope of public-works projects and thereby increase employment. In recognizing that purchase of such equipment is one phase of public works, it is realized that the employment features of it may not benefit the local people directly as much as workers of many occupations in distant communities.

Miscellaneous.—Construction and erection of fire signs, tool caches, etc.

Fire-Protection-Planning Technics

In planning a fire-protection program many factors must be considered. Some of these are: (1) Type and relative inflammability of forest fuels; (2) length of the season during which protection must be maintained; (3) climate—particularly wind velocity, relative humidity, and the prevalence of lightning; (4) topography; (5) accessibility; (6) availability of water, manpower, etc. Since some 90 percent of all fires (F. Y. 1935–39) are man-caused, the attitude of local people is also a primary factor. On the whole, man-caused fires create a bigger problem than lightning fires, but in some remote areas the latter constitute the main reason for building lookout towers and communication and transportation facilities.

Owing to the wide variation in conditions, the problems and the plans to meet them will differ considerably among regions and even within States. The types of improvements likewise vary to meet the needs of differ-

ent protection systems and these correspondingly affect the extent to which improvements form a part of the fire-protection job.

The above factors apply to all classes of forest land, commercial as well as noncommercial, and regardless of whether it is in public or private ownership. The protection problem is often more complex, however, where private holdings are interspersed throughout an area which is mainly in public ownership, or where holdings of several public agencies are intermingled. These various factors have been considered in developing the Federal forest program included in this report.

Certain technics are essential in formulating these plans. Often the application of these technics is limited by data readily available. The "minimum cost-plus-loss" principle, for example, should be the over-all objective of all protection planning. Under this principle the result obtained through protection may be expressed in terms of the cost of protection plus losses incurred in spite of it. The efficiency of the protection is directly reflected in the reduction of this total. Beyond the point where additional protection cost is balanced by reduction in loss, additional expenditures are not justified.

In practice, justifiable costs can be determined only by an accurate estimate of probable losses. The application of this principle is often complicated because of the difficulty of evaluating the damage done by fire to watersheds, wildlife, recreation values, and scenery. Technics have been developed for the application of this principle, notably strength-of-organization and travel-time standards. These measures are necessary to prevent a fire from exceeding a predetermined maximum area and to hold fires of a unit or region within the "allowable annual burn." The aim is to keep below the maximum area burned that can be tolerated without defeating the purposes for which a particular forest area is being managed.

Planning technics are not static, but are changing constantly with new discoveries. Types and priorities of individual work projects, therefore, are subject to current revision. The development of field radio equipment, for example, has made unnecessary many miles of planned telephone line. The parachuting of men and supplies to fires and the development of new types of fire trucks, power pumps, and tools, are other examples of new discoveries necessitating continual adaptation in long-time works programs.

The Future Program for Fire Protection

Because the fire-protection activity has been under study and development for many years, the character of physical improvements necessary to afford effective protection in each region is generally well known. The extent of additional physical improvements needed depends upon the technical factors involved and upon how nearly the needs are met by existing facilities. The level to which improvements have been constructed differs among the various Federal and State and private agencies and, to some extent, within regional areas of each Government agency.

Federal Forest Lands.—The volume of nonrecurrent and recurrent work in terms of man-months provided under a long-range program of public works for fire protection on Federal lands is given in tables 13 and 14. The grouping of all Federal ownerships into the one category serves the present purpose. When time permits developing the program in more detail, it may be desirable to present the information for each jurisdiction separately.

Considering the high priority of fire protection in the whole field of forestry works, the nonrecurrent program should be completed within 10 years. Needed work in some regional areas of certain agencies is nearing completion and the future program is light. In other instances, much remains to be done on certain features of the program.

TABLE 13.—*Over-all fire protection job load (nonrecurrent work), on all Federal forest lands* [1]

[In man-months]

Region	Hazard reduction	Surveys and plans	Improvements	Operating projects	Miscellaneous	Total
Northeast	37,710	170	4,580	1,190	1,950	45,600
Central	3,000	160	3,390	70	60	6,680
Lake	47,190	450	8,510	4,290	230	60,670
South	18,390	1,770	24,970	2,680	2,730	50,540
Columbia River Basin	565,610	5,020	44,410	4,700	5,400	625,140
California	127,470	2,980	30,180	4,620	5,910	171,160
Southern Rocky Mountain	16,270	1,010	14,990	1,260	300	33,830
Plains	910	90	2,070	110	100	3,280
Total	816,550	11,650	133,100	18,920	16,680	996,900

[1] Includes national forests, national parks and monuments, Indian reservations (not Federally owned but administered through Office of Indian Affairs), Oregon and California revested and reconveyed lands, and land-utilization projects of the Soil Conservation Service.

TABLE 14.—*Over-all fire protection job load (recurrent work), on all Federal forest lands* [1]

[In man-months]

Region	Hazard reduction	Surveys and plans	Improvements	Operating projects	Miscellaneous	Total
Northeast	60	----	150	910	280	1,400
Central	20	10	360	3,590	150	4,130
Lake	70	30	300	3,460	380	4,240
South	620	100	4,040	16,490	530	21,780
Columbia River Basin	2,810	210	990	22,660	40	26,710
California	520	40	2,060	23,190	1,080	26,890
Southern Rocky Mountain	90	10	420	3,810	510	4,840
Plains	30	----	80	810	----	920
Total	4,220	400	8,400	74,920	2,970	90,910

[1] Includes national forests, national parks and monuments, Indian reservations (not Federally owned but administered through Office of Indian Affairs), Oregon and California revested and reconveyed lands, and land-utilization projects of the Soil Conservation Service.

Hazard reduction constitutes the largest single activity in the nonrecurrent category (table 13). Of the total hazard reduction job load, 69 percent is located in the Columbia River Basin and 15 percent in California. Ample work opportunities of this character are available, however, in all regions, with the Plains and Central regions providing the least. Hazard-reduction work directly affects the opportunity for fires to gain headway; an increase in such work reduces the chances of disastrous fires occurring.

Nonrecurrent improvement work is the next most important item. Most of this, too, is located in the far western States.

State and Private Forest Lands.—To provide 425 million acres of State and private lands with adequate fire protection two things are necessary: (1) to increase the effectiveness on the 65 percent of this area now receiving partial protection and, (2) to bring the remaining 35 percent under adequate protection. The achievement of these two objectives would require the construction of facilities like those contemplated in the program for Federal lands. Because of the large proportion of farm woodlands and other small holdings, the per-acre requirement for such facilities would be less than for Federal lands, but obviously there is need for a substantial program. Unfortunately data are not available that would justify a quantitative estimate of a long-range program for State and private lands.

As table 15 indicates, however, the present Federal-State cooperative fire-protection organization, which is concerned in large part with recurring expenditures but includes some construction, is far short of being adequate. This is the basis for contemporary recommendations that Federal cooperation under section 2 of the Clarke-McNary Act should be raised from $2,500,000 to $9,000,000.

These estimates include lookout men, forest guards, and other personnel employed only for the fire season, but also include a basic organization which should be provided through regular budgetary procedure. To establish effective Nation-wide protection on all State and private forest lands a total of approximately $18,000,000 will be required annually for recurring expenditures.

TABLE 15.—*Additional needs for Federal-State cooperative protection under Clarke-McNary Act*

Region	Estimated annual cost	
	Dollars	*Percent*
Northeast	400,000	4
Central	200,000	2
Lake	1,500,000	15
South	6,800,000	68
Columbia River Basin	300,000	3
California	700,000.	7
Southern Rocky Mountain	100,000	1
Total	10,000,000	100

During the calendar year 1939 expenditures for the partial protection of 65 percent of the State and private lands amounted to $8,732,840, of which a large part may be considered public works. These funds were provided by:

		Percent
The Federal Government under the Clarke-McNary Act	$1,850,405	21
States, counties, and towns	4,884,800	56
Private owners and associations	1,997,635	23
	8,732,840	100

Thus, only 46 percent of the funds necessary for full protection of these lands is being provided. An increase (table 15) to establish State-wide, fully effective protection would afford increased public-works opportunities.

Financial Responsibility

In the fire-protection job, differences in forest-land ownership entail differences in administrative and financial responsibilities. On Federal forest lands, for example, the Federal Government is directly responsible for planning, executing, and financing the entire protection job.

The States, by their own laws, are responsible for the protection of forests owned by State and local governments. The cost is met by State appropriations, with Federal assistance under the Clarke-McNary Act.

State laws covering the protection of private forests cover a wide range of responsibility, particularly in regard to financing. The Western States commonly require owners not residing on the land to contribute financially for protection. In the South, private contribution is voluntary. In the Lake States and New England most protection funds are raised directly by States and towns. Clarke-McNary funds are available for the protection of private as well as State lands.

The principle of Federal assistance to States and private owners in financing fire-protection programs has long been established—by the Weeks Act in 1911 and again by the Clarke-McNary Act in 1924. This Federal-State cooperation has proven both highly popular and effective. Justification for this is based upon the premise that all forest land, no matter who owns it, is clothed with vital national interest. A similar philosophy of Federal contributions toward public-works programs for fire prevention on State and private forest lands is recommended.

Besides the direct assistance now given the States and cooperating private owners under the Clarke-McNary Act, a recent and outstanding Federal contribution was through the CCC. This activity is typical of the practical manner in which large public-works programs can be used to aid States and private forest owners in

increasing the effectiveness of their protection efforts. It is generally estimated that the CCC advanced the protection programs in many of the States by at least 10 to 15 years. Other programs, such as WPA, have also helped materially.

Basis for Evaluation

Necessity for High Priority.—Fire-protection projects that are essential to insure maintenance of the forest should generally have the highest priority among the forestry activities on any forest area. If the forest is destroyed by fire practically all expenditures on its development and improvement will have been wasted. For this reason, fire protection on any specific area should come ahead of planting, stand improvement, development of recreational facilities, disease and insect control, and most watershed improvements. It should go hand in hand with building of roads and trails, communication systems, and administrative structures.

Effective Protection.—All forest land should be protected, but not to the same extent. Each area should be protected sufficiently to insure that it will continue, without serious interruption, to yield its material and nonmaterial benefits, provided the cost of protection is not disproportionate to the results. To endeavor to eliminate all fires everywhere would result in an unsound program, for the costs would greatly exceed the benefits. Fire protection efforts are subject to the law of diminishing returns.

Probable Loss a Measure of Benefits.—The measure of benefits from fire protection is the amount of loss that would occur without it. Of course, no one can say exactly how much loss would occur on a given forest area during 1 year or a period of years if there were no protection or if the protection were incomplete. It is possible, however, to make reasonable estimates, on the basis of analysis of the forest-fire record over many years. This is analogous to actuarial estimates used in connection with fixing rates for ordinary fire insurance. Such analysis should take into account the occurrence of fires, the areas burned, and the values destroyed. It should also consider the extent of protection effort. The resulting estimates would indicate the average loss that might be expected, over a term of years, for unit areas of forest, classified according to hazard conditions and character of values at stake.

Even if methods of analyzing fire records and appraising fire losses had been completely worked out, which is not the case, it would be beyond the scope of this report to describe them in detail. Appraisal of losses in monetary terms is even more difficult than the appraisal of the corresponding vendible and nonvendible products and benefits of the forest. All of these can suffer damage, depending on the extent and intensity of the fire. With some values (vegetative cover, for example) the damage may be only temporary; with others (loss of topsoil, gullies) it may be permanent. Some values may be harmed but little (certain kinds of merchantable trees in light fires); others may be completely or partially destroyed; others may be merely impaired or made ineffective for a short period.

Some of the elements of fire damage (and, conversely, of benefits from fire protection) are:

1. Realizable (market) value of merchantable timber subject to destruction.
2. Capital value of forest growing stock.
3. Value of buildings and other structures in and near the forests, liable to destruction.
4. Economic value to dependent industries and communities of essential timber supplies that cannot be obtained from other sources, or that can be obtained only at greater cost.
5. Values of crops, orchards, farm and other lands, highways, railroads, reservoirs, ditches, and buildings subject to destruction by floods and accompanying debris that result from burning of watershed cover.
6. Values of irrigation agriculture, power plants, domestic and industrial water supply that may be impaired by irregular stream flow-floods and low water—following fires.
7. Land and water transportation disrupted by floods, and air transportation by dense smoke; interruption of air transportation interfering with defense activities in time of war.
8. Value of forage that may be destroyed by fire, including possible reduction in forage production from burned land.
9. Value of recreational features, including those that yield direct and indirect monetary income and those with less tangible, inspirational value.

Minimum-Cost-plus-Loss Principle.—Fire-protection projects should, so far as possible, be planned in accordance with the "minimum-cost-plus-loss" principle previously discussed, which is another way of expressing the maximum benefit-to-cost ratio as applied to a given area. Before this principle can be applied universally as an objective guide, much more accurate measures of fire damage and of the reduction in damage through specific protective measures will have to be devised.

Allowable Annual Burn.—In the absence of such measures, the "allowable annual burn" concept has been set up as a tentative though imperfect goal or standard, the accomplishment of which will result in an approach to the minimum-cost-plus-loss objective. The allowable burn is the maximum average proportion of a forest area that may be burned annually. This is based partly on the area that may be burned without defeating the purposes of management of the area, and partly

on experience and judgment as to the degree of protection that is attainable without excessive cost. It is usually applied to a fairly large area, such as a State, rather than to a small forest unit.

TABLE 16.—*Allowable annual burn for various forest types*[1]

Forest type	Allowable annual burn	Forest type	Allowable annual burn
	Percent		*Percent*
Longleaf pine	3.0	Douglas fir	0.2–0.3
Shortleaf pine	1.0	True fir	0.2–0.3
Loblolly pine	1.0	Larch fir	.25
Sand pine	1.0	Northern hardwood	.2
Lodgepole pine	1.0	Bottomland hardwood	.2
Oklahoma hardwood	1.0	Larch-fir-white pine	.15
Slash pine	.7	White pine	.1
Aspen	.7	Spruce	.1
Jack pine	.5	Recreation values	0–0.5
Appalachian hardwood	.5	Watersheds	0.4–2.5
Red pine	.3	Noncommercial forest	2.0
Ponderosa pine	.3	Brush and nontimbered	2.5
Mixed conifers (California)	.3		

[1] Figures from "A National Plan for American Forestry," Senate Doc. No. 12, 73d Cong., 1st Sess., p. 1399.

The allowable annual burn within any particular region will depend in part upon the forest-cover types within the region (table 16). For the United States as a whole, the allowable burn on forest land is estimated to be somewhat less than 0.5 percent. The lowest ratio, 0.14 percent, is assigned to the Northeast.

The allowable burn is an average figure. In some forest units larger areas may be burned in some years without justifying greater expenditures for protection (except as these may be required for fire-fighting). Under certain circumstances, however, extra expenditures may be justified to prevent single fires in any year from exceeding a given size. Examples are recreation areas, critical watersheds, and demonstration and experimental forests. One medium-sized fire in such a tract may largely or utterly destroy its value, with much greater loss than would result from a fire of the same size elsewhere. There is justification for special expenditures on such key tracts.

Technical Soundness.—It is axiomatic that any project should be technically sound. It should be efficiently planned on the basis of adequate surveys or other studies. There should be assurance that the methods employed will accomplish the desired result. It should be no more costly than any alternative method of accomplishing this objective. For example, piling and burning of slash or windfall may under some circumstances be much more expensive but not more effective than intensive patrol during the few seasons that it constitutes a hazard.

Probable Benefits.—There should be evidence that the work will make a significant contribution toward holding the average annual burn down to the allowable standard for the region, forest type, or smaller area, or at least that it will reduce the average fire loss by an amount at least equal to its cost. For example, a lookout tower by increasing the seen area or a road by opening up a remote part of the forest may result in greater speed of attack so that fires can be held to much smaller size than would otherwise be the case. Likewise, especially intensive measures, such as fireproofing around much-used recreation areas, should be justified by explanation of the special hazard or the special values involved.

Timing and Priorities.—Protection of forests from fire is prerequisite to forest-land management. It is a job that must be done as soon as possible, and cannot be delayed until need for employment arises. However, there is so much to be done that it is not likely to be completed in less than 10 years, if so soon as that. Even after the program of nonrecurrent work has been completed, there will be a large year-to-year job of maintaining and occasionally rebuilding structures, firebreaks, and trails, and of routine fire-prevention and suppression activities. Emergency conditions will continue to arise, as they have in the past, which will necessitate immediate remedial works projects such as hazard reduction following blowdowns, burns, or forest-insect epidemics.

Until the nonrecurrent works program is completed this will constitute a fairly flexible reservoir of projects that can be drawn upon to provide jobs. Except for seasonal limitations in some regions, most of the work is of such character that it can be expanded or contracted on short notice, without serious disturbance to the program as a whole. In determining the order in which the various projects will be taken up, the following are some of the principles that should be considered:

1. Work designed to relieve conditions that threaten human lives or the existence of communities should have first priority. An example is the reduction of extreme hazard conditions adjacent to settlements.

2. Conditions of high hazard should generally be remedied before conditions of low hazard. The first steps in reducing the loss from fire are likely to have a much higher benefit-cost ratio than the last or marginal projects.

3. Protection of present values should take precedence, other things being equal, over protection of potential but more or less uncertain future values. For example, accessible areas of merchantable timber or areas already used extensively for recreation would be protected before areas of inaccessible timber or potential but unutilized recreation areas, if the other values were equal.

4. Protection against loss that cannot be repaired within the near future should usually come ahead of protection against equal damage that can be quickly repaired. For example, a building can be rebuilt in

a few weeks or months, but a stand of mature timber cannot be put back in less time that it takes for trees to mature.

5. In times of unemployment, projects that will provide many jobs may be preferred to projects, otherwise equally desirable, that will not. Conversely, in times when jobs are plentiful it may sometimes be advisable to give low priority to the projects that require the largest volume of labor.

Forest Transportation Facilities

Need for Facilities

Highways, roads, and trails are essential for the satisfactory management of forest lands. Every landowner must have certain of these facilities, in order properly, efficiently, and economically to administer his property and protect, develop, and utilize its resources. The need increases with the size of the holdings and varies with the type of resources and their use.

Transportation needs in forests vary also with geographic location, topography, elevation, and character of the timber. They are governed largely by the economic requirements of forest management. The service standard for each highway, road, or trail depends upon the character and volume of use, and its cost should be justified by an evaluation of the benefits to be obtained.

Forest Management.—The diversified interests and needs of all of the forest users, particularly in large units such as national forests, parks, or Indian lands, impose a huge task of resource management upon the administrator. This can be carried out satisfactorily only if there are sufficient roads and trails for ready access to the lands, properly located and adequate in construction.

Permanent timber supply, water flow, forage crops, recreational and scenic values, and other resources can be assured only through adequate protection from fires. The objective is to hold all fires to the smallest size practicable within economic limits. To accomplish this, adequate roads and trails to make the areas of potential fire risk quickly and easily accessible to the protection organization are the greatest immediate need.

Resource Utilization.—In many localities the day of railroad logging has largely passed. Truck logging on roads has been found more economical and much more flexible in harvesting the crop. A road network carefully laid out will serve present logging needs with the minimum investment and at the same time remain part of the physical forest plant available for use in future cuttings. Most timber-utilization roads serve small operators, as well as large ones, and their benefit to local communities is substantial and far-reaching. They facilitate economical sustained-yield management in place of the "cut-out-and-get-out" practice so prevalent in past years.

Forest range lands enable thousands of small ranch owners to supplement their livelihood through the grazing of domestic stock. Movement of stock to and from the range and its handling while on the range are greatly facilitated by roads and trails; losses and costs are greatly reduced; local incomes are increased and local communities stabilized through better management and increased returns.

The wildlife population of the forests, itself a major resource, requires a considerable degree of management for full utilization. The forest road and trail system plays an important part in the economical "harvesting" of the fish and game crop.

Geological studies and past experience indicate that much mining development is still to be expected on forest lands. Some of the largest deposits of strategic minerals have been found in the forests. Limited progress has been made possible by means of roads and trails built to serve other needs and uses but, until adequate provision is made for completing the forest transportation system as a whole, substantial areas valuable for mineral production will remain inaccessible for that purpose.

Three-fourths of our forest land is valuable for watershed protection. Safe, proper, and efficient functioning of water works, irrigation systems, and power plants requires that the structures and watersheds be accessible. Dams, spillways, ditches, flumes, and pipe lines must be maintained, and fires and contamination must be prevented, all of which requires transportation facilities.

Public Service.—The volume of recreational travel on forest-land highways, roads, and trails exceeds that for any other resource or use in almost all regions. Between 1925 and 1940 the number of recreationists on forest lands increased more than 600 percent. Particularly on national and State forests and parks and national monuments this use is reasonably certain to continue and to increase year after year.

The widespread distribution of the forested area is such that of the 80 to 100 million persons whom traffic counts include in "public travel" each year, nearly all include in their journey some travel across forest lands. In the case of local residents, this may be on Federal-aid, State, forest, or county highways; on county farm-to-market roads, or on development roads constructed by a Federal agency. Through travelers are more apt to travel trunk highways alone. But in the aggregate, public travel on forest routes has reached a tremendous volume and continues to increase each year.

Multiple-use Needs.—Although the need for transportation facilities has been discussed from the separate viewpoints of forest management, resource utilization

and public service, this clear-cut distinction does not exist on the ground with regard to usage. The same facilities are used for both administration and protection, and many of them also carry heavy recreational and public travel as well. Similarly, the highways, roads, and trails that fulfill the above-described functions are largely used for several types of resource utilization.

Classes of Facilities

The construction and service standards of the facilities now existing and further required on forest lands vary with the intended use or combination of uses for which they are built. No higher standard should be planned than that required to carry with safety the normal peak traffic load to be expected. Traffic trends must be taken into account and standards provided that will accommodate any increase that is reasonably certain to occur.

Forest-land highways may fall within any one of several systems, namely, Federal-aid, State, forest, county, or other. The construction standards are more or less uniform. They are all two or more lanes in width, hard-surfaced, with standards of gradient and curvature based upon intended usage. In general, a highway is an all-year route designed to carry both heavy freight and high-speed passenger traffic between cities and towns, either as a local branch or an integral section of a designated through route.

Forest-development roads, from the standpoint of forest-land administration, protection, and utilization, form an invaluable part of the transportation system. They include the spurs and feeders that lead from the back areas, and which combine as they lead outward to carry a large proportion of forest products to market, to serve as a mainstay for administration and fire protection, to bring in recreationists, and to furnish transportation for forest communities and local residents. Most of these roads are unsurfaced and of single-lane width with turn-outs. The grades are steeper and permissible curvature is greater than on highways. Although many at higher elevations are closed by snow during winter months, the aggregate annual traffic that they bear is very large.

Forest trails are designed for horse and foot travel only, and are indispensable for administrative travel, protection, range and wildlife management, and recreation beyond reach of development roads. Although trail travel is slow, many thousands of square miles of forest lands are served only by trails. Some of these eventually will be replaced by roads, but there will always be hinterlands in which roads are not economically justifiable and for which trails will continue to serve.

Forest waterways serve forest lands in certain localities largely as auxiliaries to highways, roads, and trails. For transportation use, some improvements will, from time to time, become necessary, but the more immediate need is for the portages, wharves, boathouses, and similar structures included under "Improvements."

Landing fields, while perhaps technically a part of the transportation system, are also included under "improvements." Railroads, trams, chutes, and flumes are usually constructed by private capital for specific purposes or to meet local needs, and will not be discussed here.

Variation in Transportation Requirements

By Ownership Classifications.—The management policies peculiar to each class of forest ownership result in a wide variation in the character and intensity of road and trail development. National forests, national parks and monuments, Indian lands, O. and C. revested lands, and other Federal and some State or local government lands designed to provide a continuous yield of timber and other resources or benefits have, in most cases, insufficient facilities at present to meet the objectives of good management, but they do have systematic plans for completing the system as funds permit.

Less progress has been made on a large part of the State and local government holdings, although their needs compare closely with those of Federal lands. Lack of interest, lack of permanent policy, and shortage of funds are largely responsible.

Some private holdings actually have a greater mileage of development roads and other facilities per unit of area than Federal lands in the same locality, but as these are largely to serve special needs, the forest system as a whole is deficient in both mileage and standards. It is estimated that more than half of the private forest land has inadequate transportation to meet the objectives of a long-range forest program, and that this condition exists generally on the larger private holdings. Economic conditions tending to force liquidation of the timber have often resulted in building only a bare skeleton system for protection, and the few routes essential for logging as each block of timber is cut. The eventual needs of these lands for strictly forest transportation will in some cases be somewhat less than for the public forests.

In spite of the differences that now exist in the needs of the lands of the several ownership classes, completion of the transportation systems on all of them can be facilitated by a public-works program. In many cases the lands are closely intermingled. The facilities needed are comparable, even though the systems required may not be equally intensive. The same skills and equipment are needed. Federal financial participation will vary, but the work remains to be done, and it could be economically combined for any single

locality on a cooperative basis agreed upon in advance among the agencies or owners involved.

By Location, Topography, and Class of Timber.— The wide geographic distribution of forest lands has marked effect on road and trail development. Accessibility to cities, towns, and markets has brought about intensive use in parts of all regions, with the consequent intensification of transportation facilities existing or needed. On the other hand, less accessible but equally valuable lands often tend to lag in the facilities provided, and reach an extreme where large "back country" forests of potentially high value now have totally inadequate transportation, either existing or proposed, to safeguard them from fire.

Within each region there are wide variations in topography and timber types. These two factors, combined with ownership and use, dictate to a considerable extent the character and intensity of transportation required. For example, certain high subalpine areas of the West, bearing mainly watershed-protection forest and chiefly valuable for their grazing, recreational, and watershed values, require only a few roads, with an auxiliary network of trails to serve the users and fire-protection forces. Close to these areas, and often adjoining them, are dense stands of commercial timber in immediate demand for selective logging and at the same time heavily used for recreation and other purposes. These lands require much more intensive transportation than the noncommercial protection forests.

Place of Public Works in Building the Transportation System

Forest-land highways for the most part are built by the Federal Government or by the States. They are maintained largely by the States, but the Federal Government has rendered appreciable assistance. A few local governmental agencies also build and maintain these facilities, but private owners seldom do. The Federal Public Roads Administration and the State highway commissions are staffed and organized to handle surveys and construction work. Maintenance in practically all cases is amply provided for on a stable budget basis, but construction has proceeded at an irregular pace, subject to the annual variations in the availability of funds. Highways are built largely under the contract system. Their construction calls for a higher percentage of specialized and skilled labor than development roads, but on the other hand they are frequently located near populous centers, where work is needed, and require many man-months of labor per mile built. Their construction is adapted to a public-works program; their maintenance is not so well suited to this purpose.

Forest-development roads on Federally owned lands and those built by State, county, and other local governments, are practically all under the supervision of trained road personnel organized to handle all types of road work. Here again, however, construction has been irregular in progress, owing to varying annual appropriations, and financing of both construction and maintenance sometimes has been precarious. On private lands the history of road building is varied. Some forest properties are adequately supplied with well-maintained routes, but the others are poorly served and maintenance is almost nonexistent.

This class of facility lends itself well to a public-works program. Needed projects are widely distributed, and the skills required are less than those for highways. Some development roads are isolated, but the potential volume of the work reservoir more than compensates for this fact. Here again, construction is especially suitable for a work reservoir, but maintenance, because of its rapidly shifting nature, can best be handled under regular appropriations.

Forest trails follow closely the pattern of development roads. The large mileage existing, particularly in parts of the West, imposes a heavy seasonal burden in maintenance work and on maintenance funds, which makes this type of facility more difficult to handle in many respects than the more easily accessible highways and roads. Trail construction is in some respects less satisfactory as a work reservoir than is road construction. On the other hand, a larger percentage of the total cost of trails is for wages of common labor and relatively fewer skilled workers are required.

Transportation Planning

An excellent form of transportation planning technic has been developed and is used on some Federal lands, those of certain States and local governments, and a few private properties.

The Forest Service has made an intensive study of traffic requirements for the national forests, based on a combination of public travel needs with the administration, protection, and utilization needs of the forests themselves. Complete plans have been prepared, in which each project is justified by a computation of the expected benefits as compared with the costs of construction and maintenance.

The National Park Service and the Indian Service have prepared plans somewhat similar to those of the Forest Service for their forest lands; the former limited largely to recreation, public travel, and protection requirements; the latter covering other utilization needs as well, including grazing and timber utilization.

The Public Roads Administration in cooperation with the States has under way a similar plan that starts with market and county roads, but concentrates to a large degree on highways. This plan, based upon

traffic counts, covers the entire United States and will require a number of years for its completion. It deals with both forest and nonforest land, but does not consider the forest needs except as they now impose traffic loads on highways or market roads, mostly outside the forests.

State and local governments in connection with the CCC, WPA, and other relief work of the past several years have proceeded to varying lengths with their planning for forest transportation. In a few cases, as, for example, some of the Northeastern States, complete plans have been made and are being followed; on the majority of State forest lands, however, progress has been slow and plans are fragmentary in scope and character.

As already indicated, private interests in large holdings concentrate largely on providing a few protection facilities pending the start of logging, followed by logging plans immediately in advance of cutting. Less information is available on transportation facilities on State, local, and private than on Federal lands, in regard to existing facilities and those that are needed, hence the statistics quoted in the following sections are less accurate for those lands. In general, it is evident that universal adoption of systematic all-purpose transportation planning not only would expedite progress for all classes of land but would also assure construction in priority order of the facilities most urgently needed, at unit costs justified by the returns to be expected.

Present Status of Forest Transportation System

The mileage of all transportation facilities serving forest lands of the United States has never been accurately compiled. In the case of highways there is room for wide difference of opinion. It might well be argued that 75 percent of the entire highway systems serves forest lands in one way or another and that at least half of the minor road system built by local governments serves these areas. The other extreme would be to consider only mileage actually on forest lands. The following tables take a "middle-of-the-road" course and include mileage of roads and trails on or tributary to forest lands [1] which, so far as can be determined, are of real value for their administration, protection, and utilization. For all reserved Federal forest lands the figures are quite accurate; for the unreserved public domain and other small Federal holdings the estimates will require revision. For local-government and private lands as a whole, much less reliable data are available. It is believed, however, that tables 17, 18, 19, and 20 reflect present conditions quite closely. As time goes on and planning progresses, the estimates can be improved.

[1] Forest lands as used herein comprise a total of 630.1 million acres, consisting of 169.5 million acres Federal, 26.8 million acres State and local government, and 433.8 million acres private.

TABLE 17.—*Existing highways serving forest lands*

[In miles]

Region	All Federal forest lands	State and local government forest lands	Private forest lands	All forest lands
Northeast	810	2,600	23,900	27,310
Central	1,250	160	12,600	14,010
Lake	2,360	1,500	3,600	7,460
South	7,500	870	89,400	97,770
Columbia River Basin	5,700	280	4,300	10,280
California	3,270	10	8,500	11,780
Southern Rocky Mountain	8,800	45	2,100	10,945
Plains	35	----	3,500	3,535
Total	29,725	5,465	147,900	183,090

TABLE 18.—*Existing development roads serving forest lands*

[In miles]

Region	All Federal forest lands	State and local government forest lands	Private forest lands	All forest lands
Northeast	700	3,700	28,300	32,700
Central	2,180	420	45,600	48,200
Lake	6,900	9,100	10,900	26,900
South	14,900	1,300	223,500	239,700
Columbia River Basin	31,600	920	17,300	49,820
California	23,600	40	37,600	61,240
Southern Rocky Mountain	22,100	110	5,200	27,410
Plains	65	----	32,200	32,265
Total	102,045	15,590	400,600	518,235

TABLE 19.—*Existing foot and horse trails serving forest lands*

[In miles]

Region	All Federal forest lands	State and local government forest lands	Private forest lands	All forest lands
Northeast	1,425	6,100	55,600	63,125
Central	----	35	3,400	3,435
Lake	970	1,800	4,500	7,270
South	5,350	770	78,100	84,220
Columbia River Basin	79,400	1,100	7,900	88,400
California	21,800	70	4,900	26,770
Southern Rocky Mountain	37,500	55	2,700	40,255
Plains	----	----	----	----
Total	146,445	9,930	157,100	313,475

TABLE 20.—*Intensity of existing forest development roads in miles per million acres served* [1]

[In miles]

Region	All Federal forest lands	State and local government forest lands	Private forest lands	All forest lands
Northeast	425	620	520	525
Central	1,520	1,210	1,655	1,645
Lake	950	650	315	485
South	1,040	690	1,150	1,140
Columbia River Basin	575	226	425	500
California	1,350	575	1,230	1,270
Southern Rocky Mountain	305	190	175	265
Plains	1,410	----	1,450	1,450
Average	600	580	925	820

[1] For purposes of comparison, the State of Delaware has an area of 1¼ million acres.

It is apparent from table 20 that development roads are neither sufficient nor well balanced; that lands of certain owners are deficient in mileage; and that many more miles in the aggregate are necessary to assure satisfactory management of all of the forest resources. Even these figures fail to bring out the situation completely, however. Lands of some owners, particularly private and local government holdings, show a relatively high intensity but the bulk of this mileage is adjacent to forest settlements so that large portions of the holdings are inadequately served. These inequalities can be discovered and remedied only by systematic transportation planning.

In certain localities, much progress has been made during the past 10 years, partly as a result of construction under work-relief programs between 1933 and 1940. On some Federal lands, many miles of development roads and trails were built under NIRA and CCC programs, and the CCC extended this construction to include some State and private forest lands. During the same period, however, there has been a considerable shrinkage in regular appropriations, both Federal and State. In many instances these appropriations scarcely have covered the recurrent maintenance requirements of roads and trails already built and have left little or nothing for urgently required new construction. Private interests have confined expenditures mainly to logging roads and a few urgently needed protection roads.

In general, the present transportation system is insufficient in scope, poorly balanced by regions and classes of ownership, and precariously financed from the standpoint not only of nonrecurrent (construction) requirements but also of recurrent (maintenance) costs.

Future Program for Forest Transportation

Mileage Estimates.—The size of the program required to provide adequate transportation for forest lands is tremendous. The need is not confined to one region, a few States, or one or two classes of ownership. It is Nation-wide and calls for careful advance planning, a large outlay of funds, and efficient execution of work on the ground.

Tables 21, 22, and 23 show, according to the best estimates available, the additional mileage needed to complete the transportation system, by regions and classes of ownership. As with tables 17, 18, and 19, complete and accurate data are not at hand. For certain Federal and State holdings, long-range plans and reasonably accurate estimates have been prepared. For local-government and private lands, estimates based upon acreage and relative intensities of the systems must serve. The over-all picture is believed to be reasonably well balanced and on the conservative side. It will be subject to revision when additional reliable information is obtained.

TABLE 21.—*Additional highways needed to serve forest lands* [1]

[In miles]

Region	All Federal forest lands [3]	State and local government forest lands [2]	Private forest lands [2]	All forest lands
Northeast	125	110	330	565
Central	80	10	85	175
Lake	520	320	70	910
South	560	20	2,100	2,680
Columbia River Basin	1,800	20	120	1,940
California	750	2	240	992
Southern Rocky Mountain	4,330	2	480	4,812
Plains	7		180	187
Total	8,172	484	3,605	12,261

[1] Includes necessary betterment of existing mileage.
[2] Distribution among Federal, State, and private forest lands of proposed public works, in this and all following tables, is based on present ownership.

TABLE 22.—*Additional development roads needed to serve forest lands* [1]

[In miles]

Region	All Federal forest lands	State and local government forest lands	Private forest lands	All forest lands
Northeast	335	1,400	3,100	4,835
Central	290	60	5,500	5,850
Lake	3,000	3,000	3,300	9,300
South	3,050	450	31,300	34,800
Columbia River Basin	12,700	750	4,500	17,950
California	14,300	50	5,600	19,950
Southern Rocky Mountain	5,100	25	2,200	7,325
Plains	45		5,100	5,145
Total	38,820	5,735	60,600	105,155

[1] Includes necessary betterment of existing mileage.

TABLE 23.—*Additional foot and horse trails needed to serve forest lands* [1]

[In miles]

Region	All Federal forest lands	State and local government forest lands	Private forest lands	Total
Northeast	700	1,100	10,400	12,200
Central	20	35	6,600	6,655
Lake	590	450	1,100	2,140
South	1,280	100	11,700	13,080
Columbia River Basin	24,900	1,500	39,600	66,000
California	5,100	25	24,300	29,425
Southern Rocky Mountain	16,300	290	13,400	29,990
Plains				
Total	48,890	3,500	107,100	159,490

[1] Includes necessary betterment of existing mileage.

The benefits to be derived in better administration, more complete protection, and sustained utilization of all resources on the vast acreage of forest land justify the completion of this transportation system. In all known previous reports, the mileage of additional transportation facilities required by each class of governmental agency and local political subdivision has been treated separately. The mileage for private land has seldom been considered at all. In the aggregate it is large, but taking into account the forest areas that

it serves, the size of the population dependent upon these lands for one or more of their resources, and the fact that transportation planning permits a close determination of costs versus benefits for each individual project, expenditures for this purpose are believed economically sound.

As a Public-works Program.—In "Place of Public Works in Building the Transportation System," above, the adaptability of the three main classes of facilities to such a program was discussed. Under "Basis for Evaluation," below, it is covered further. At this point, however, the magnitude of the task of construction and betterment which remains to be done may be restated in terms of labor requirements. This is done in table 24, which is based upon the assumption that a normal amount of modern machine equipment will be used. The increased efficiency and lower costs so obtained, as compared with hand work, appear to warrant such methods. Even so, the potential work reservoir is large.

TABLE 24.—*Estimated work reservoir afforded by completion of the highway, development road and trail systems needed to serve forest lands, in thousand man-months*

[In 1,000 man-months]

Region	Forest-land highways	Forest development roads	Forest trails
Northeast	450	765	15
Central	175	85	15
Lake	290	300	5
South	1,230	975	10
Columbia River Basin	815	370	135
California	570	545	200
Southern Rocky Mountain	670	220	65
Plains	35	30	
Total	4,235	3,290	445

A special public-works program will vastly expedite completion of the needed facilities. It should supplement but it cannot replace regular programs. Certain projects will be found not adapted to a special works program because of their location, type, or urgency factors involved in their construction. In completing the system and maintaining it thereafter, regular annual appropriations will be needed.

In some instances, maintenance will offer a supplemental source of employment. It is seasonal in character and crews continually move from place to place, which makes it particularly adaptable to the program of recurrent work. Annual maintenance can be handled efficiently and economically only by experienced crews trained in this work and requiring but little day-to-day supervision.

Owing to variations in locality, climate, and elevation, construction of transportation facilities may be considered a year-round reservoir of work, and one adaptable to work needs in any State or Territory, or generally throughout the country.

The work calls for a wide variety of skills and experience, so almost 100 percent of employable men will be suitable for some phase of the projects. Trail construction requires the extreme in stamina. Highways, now largely built under contract, call for more specialization in training and ability. Development roads could well absorb the remaining labor to be found in any average locality or community.

For much of the work, plans are already available; if not, they can be prepared on relatively short notice. Nearly all road-building agencies have at least a skeleton organization of experienced overhead staff, trained to supervise work of this nature and capable of temporary expansion to carry any reasonable load of work. Similarly, equipment necessary for the job is on hand in most localities.

Financial Responsibility

Financial responsibility for the forest transportation system includes the financing of the construction and betterment required to complete the system, and concurrently with construction and thereafter, of the maintenance necessary to preserve the facilities in good condition. This responsibility should rest on each owner in proportion to the benefits that he derives. This is not the case at present.

Federal responsibility includes financial participation in construction of most of the highways on Federal lands and in addition substantial Federal aid to the States for construction of routes serving non-Federal forest lands. It covers a large portion of the cost of construction and maintenance of development roads on or adjacent to national forests, national parks and monuments, Indian reservations, and other Federal holdings. Here the Federal responsibility is reasonably clear-cut, although local governments in many instances participate in payment of the costs.

On other forest lands, however, scattered and interlocking ownerships—Federal, State and local government, and private—create a problem in financial responsibility which has grown with the years to a point where the burden is often misplaced or thrown off entirely. A realignment of responsibility is needed in such places, with provision for comprehensive long-range plans that will lead toward early completion and adequate maintenance of the eventual system.

In the case of trails, the Federal responsibility is more clearly defined than for highways and development roads. Trails are usually strictly local in their benefits. The Federal Government generally bears the costs for projects on or adjacent to its holdings.

State responsibility with respect to highways includes participation with the Federal Government on Federal-aid routes that serve some of the non-Federal lands, and full cost of construction of State highways

within the same areas. The States carry most of the cost of highway maintenance except for limited participation by local-government agencies. The States participate with local governments to a varying degree on both construction and maintenance of development roads outside Federal lands. As mentioned above, interlocking ownerships create a difficult problem in financial responsibility for these roads. As for trails, State activity is practically confined to a comparatively small mileage in State forests, parks, and other small State properties.

Local governments pay for a minor amount of highway construction and maintenance. They pay for construction and maintenance of a considerable mileage of county development roads traversing forested lands, but of practically no trails.

Private participation in these efforts (except through taxation) is limited to the roads and trails that directly serve private lands where publicly constructed and maintained routes are not available. For the most part, these are relatively short roads and trails connecting with the public system, and those built to protect and utilize timber and other values.

The whole subject of financial responsibility of Federal, State and local governments and private owners merits comprehensive and detailed study that will lead toward proper distribution of the load, so as to bring about more orderly and rapid progress in completing the transportation system on all forest lands.

Basis for Evaluation of Projects

Technical Soundness.—The rapid development of automotive equipment since 1895 has increased the need for transportation facilities far beyond the ability of available funds to meet that need. Nevertheless, the projects so far built have resulted, among other things, in the development of reliable methods of determining their soundness; of a high degree of engineering technic; of skillful construction methods; and efficient maintenance procedure. Only those projects should be approved for construction on which there is assurance that these standards will be met.

Benefits and Costs.—The welfare of 132 million people in 48 States is dependent to some degree on the forests or on some of their individual resources or services. The forest transportation system is now less than 50 percent complete, taking into account the costs of improving existing roads. The uncompleted portion of the system is needed not only for fire protection to assure continuance of our present benefits, but also to meet all of the other needs that result from the demands of a growing population.

The economic life of many communities is directly founded on sustained utilization of tributary forest resources, and is dependent upon transportation facilities over which to transport forest products to market. Numerous other communities, heretofore deriving their income from other sources which have been curtailed or eliminated, have fallen back on forest industries for their backlog, and need the forest transportation system for supplying or carrying on those industries.

National defense requirements in increased production of lumber and timber products, meat from forest ranges, minerals from forest lands, and water and hydroelectric supply for communities and industries, all require an expansion in transportation facilities.

Local residents also receive substantial supplementary income from seasonal maintenance of existing transportation facilities. Such maintenance furnishes approximately 530,000 man-months employment each year. Construction of additional mileage will add to this amount, but betterment of existing mileage to a satisfactory standard will partially offset the increase by lowering maintenance costs on the improved roads. When the system is complete, approximately 590,000 man-months will be required each year for maintenance.

Through the assignment of predetermined values to units of traffic for protection, administration, timber utilization, and recreational and general travel, and by means of traffic counts, present and projected, it is feasible to arrive quite closely at the benefits to be obtained through the construction or betterment of any facility. Using accurate cost estimates for the project, prorated over its estimated life, and including annual maintenance charges, it is possible to compute the annual cost.

Financing.—The financial responsibilities covering construction and maintenance of the forest transportation system have been discussed above. Under normal circumstances, the landowners or forest users receiving substantial benefits from any transportation facilities should be expected to finance, directly or indirectly, an equitable share of the construction and maintenance costs of these facilities. Where multiple use is involved, or where several owners or jurisdictions participate in the benefits, it is reasonable to expect that each group of users or owners should participate substantially. For many projects this is complicated to a certain degree by public-service usage. Application of the general principles of financial participation must therefore be tempered to some extent by limitations on the planner's ability to apply the rule so as to include all of the minor uses.

During periods of heavy unemployment, the Federal Government may well assume costs beyond its normal share, as a means of affording relief. The cost of such work may or may not be reimbursed to the Treasury at a later date through direct repayment or by a lightening of Federal responsibility elsewhere—usually it is not.

But since the relief work is financed ultimately through taxation, at least a part of its cost falls on the beneficiaries at some time or other.

Coincidence with Regional and Functional Plans.—The plans of governmental agencies, Federal, State, and local, are in various stages of development. In general, however, they are well founded on evaluated needs for functional or general usage. Transportation facilities constructed to date on private holdings have, for the most part, been provided for specific purposes or to meet well-determined needs.

A rapid expansion of construction at any time will call for judgment and care to insure adherence to predetermined plans and to provide for application of the cost-benefit ratio before expenditures are authorized on any project.

Priorities.—Evaluation of the relative needs and priorities among classes of facilities, ownership categories, regions, and individual projects must rest in part upon a careful analysis of individual cases and circumstances. Protection roads and trails needed to preserve the basic resources should be given high priority. Nevertheless, sudden emergencies such as insect infestations or large fires may necessitate immediate construction of facilities for timber salvage in advance of some of the less urgent protection projects elsewhere.

Dual- or multiple-purpose roads needed by a large number of individuals should, in most instances, take priority over single-purpose projects serving relatively few. Timber-utilization roads required immediately to maintain existing forest communities should ordinarily be constructed ahead of those planned to open up new or untapped areas.

Priorities change from year to year and are affected by unforeseen economic and resource conditions. The administrator in charge of the forest must apply the cost-benefit ratio, weigh the circumstances, and continually realign his priorities to meet constantly changing conditions. The fact that a rather wide flexibility is possible, both in location and in types of projects undertaken, makes this work extremely well adapted to a public-works program. Such a program will not replace construction carried on by means of regular appropriations, but will supplement it and appreciably hasten the date of final completion.

Application of Expenditure—Labor and Materials.—On highway projects, under present conditions, approximately 35 to 40 cents from each dollar spent is paid for direct on-the-job labor. Of the remaining 65 or 60 cents, a large share goes to pay for indirect labor elsewhere; to the workers who fabricate culverts, the refinery employees producing gasoline and lubricants, the powder-plant workers making explosives, the mechanics building road machinery, and similar labor throughout all parts of the country.

In development-road construction, direct labor receives from 50 to 65 cents from each dollar spent, or at least 50 percent more than on highways. The remainder is distributed largely to indirect labor as described for highways.

Trails produce the highest direct-labor payments, or 65 to 85 cents per dollar total, since they require a high percentage of hand labor and few materials.

Experience during the past 10 years indicates that economy is effected, labor is more easily and effectively utilized, administration of a works program is expedited, and results show far greater permanent returns if funds are made available for materials and equipment operation along with those for labor pay rolls in the approximate ratios indicated above, and with sufficient elasticity to permit adjustment to suit individual projects.

Forest Improvements

Nature and Scope of Activity

Many kinds of buildings and other improvements, including communication systems, are essential for the satisfactory management of large forest properties. Since these properties are mostly remote from towns where such facilities could be rented, the owner, whether Federal Government, State, or private corporation, must usually build requisite office and living quarters and related facilities, either alone or in cooperation with other owners. Farm woodlots and other small forest properties require few if any structures of the types with which this chapter is mainly concerned.

Single- and Multiple-Purpose Facilities.—Some improvements primarily serve only one function or use. Some serve timber management, some fire control, others range management or recreation. For example, a lookout tower may serve only fire control. A fence to control the grazing of stock may serve only range management, and so on. Such single-use improvements are mentioned in this chapter, but are not included in the estimates for new construction. They are included elsewhere in this report in chapters on forest protection, timber-resource management, etc.

Obviously, the line between multiple-purpose and single-purpose improvements is not always clear. However, any overlap between this and other sections is of minor significance. This section deals mainly with the improvements for general forest administration and management functions that to a substantial degree serve more than one major forest use. These are simple office quarters and other structures, such as dwellings, equipment-storage buildings, repair shops, warehouses, landing fields, barns, and fences.

Often improvements, constructed primarily for one purpose, actually serve more than one forest activity.

Summer-campground buildings may house a forest-stand-improvement crew in winter. A lookout tower for fire detection may be adjacent to a recreation area where climbing the tower provides a thrill for nearly every visitor, and the educational value in fire prevention is of important lasting benefit.

Communication systems connecting headquarters locations with each other and with outlying guard and lookout stations are essential to management. Radio is used to the fullest practicable extent, but the telephone is the mainstay of the forest system. Without it the fire detection scheme, depending on lookouts in towers stationed at carefully planned locations, would largely be useless.

Shelters and various other improvements are needed for campgrounds, winter-sports developments, and other recreational areas. These are designed to maintain sanitary conditions and facilitate public recreational enjoyment.

Water developments, such as improvement of springs, pipe lines, wells, cisterns, and the like, are required at headquarters stations and recreation areas.

A comprehensive research program in connection with various phases of forest management and resource utilization is a going activity on forest lands. Large areas of experimental forests are set aside as field laboratories for this work. For these long-term investigations, offices, housing for personnel and equipment, laboratories, and related facilities are essential.

There are also required certain improvements of a nonstructural nature, such as the clearing of debris and fallen timber along roadsides; the improvement of fishing streams; and soil erosion control.

Diversity of Improvement Requirements.—The various forms of Federal forest ownership, being subject to different land-use policies, are responsible for a wide variety in the character and intensity of existing and planned improvements. The improvements required for heavily used park areas, for example, are quite different in type, size, and intensity from those needed on other forest lands where the management policy provides for logging, mining, grazing of stock, hunting, and other resource development and utilization.

In general, headquarters stations and related improvements vary in size and scope with forest-resource values and the intensity of management and utilization. Because of differences in value of the forest resources or variations in market demand, there is no fixed standard for the improvement facilities justified for protection and management of forest property.

Climate and topography are important factors. Architectural character of buildings should harmonize with local environment. Many structures are located at high elevations where heavy snowfall and severe storms occur. Structurally they must be sturdy. Forest lands are usually broken up for management by natural geographic lines—the size and shape of the areas are always different. Therefore there is no uniform spacing or layout for improvements. Even the geographic nature of the areas, varying from heavily timbered flat lands with numerous lakes to mountain peaks with only subalpine timber types, dictates a variation in improvements and utilities required.

Many of the improvements are unattended or unoccupied for long periods of the year. On some forest lands that are extremely remote, it would not be wise to construct more than a minimum of field facilities. However, where field improvements are held to a minimum the headquarters facilities may necessarily be somewhat increased.

The extent and type of improvements vary also with management policies, concentration of public use, and the protection problems. The improvement and communication needs in all cases should be guided by recognized standards for areas of similar or like management that are well equipped or for which comprehensive plans have been made.

An area may pass by stages through a series of needs for improvements, as requirements develop with land acquisition, planting, protection, and then later with utilization of the resources in timber, range, and other forest values.

Public-Works Opportunities in Improvement Construction

The needed improvements are largely simple in type and provide work for men living in the nearest communities. The construction program will require an assortment of labor, trades, and skills as well as a moderate amount of ordinary machinery, heavy tools, and equipment.

For all Federal forest lands, the required new construction (nonrecurrent work) will provide more than 728,000 man-months of employment. This Federal works program will increase in magnitude as additional forest land is brought under Federal ownership. For every average 1,000 man-months of work, the labor opportunity represents a very favorable ratio of common labor and trades, as follows:

	Man-months
Unskilled laborers	300
Semiskilled trades	200
Skilled trades	250
Helpers or apprentices	150
Draftsmen, surveyors, timekeepers, clerks	50
Supervisors	50

The improvement-construction program can be speeded up for relief of unemployment or slowed down as other employment opportunities become available. This is exactly what occurred on reserved Federal lands

during the past 7 years, when intermittent employment was provided many thousands of men on emergency relief rolls, in the construction of all kinds of improvements.

Most Federal agencies have prepared, and keep currently revised, comprehensive manuals or handbooks on telephone systems, fish-stream improvement, water development and sanitation, lightning protection, and all types of building construction. Acceptable designs for many types of structures are on hand. These plans and handbooks make it possible to get together quickly the necessary detailed plans for a greatly expanded improvement-construction program. Agencies having regular staffs of employees can effectively use their regular personnel in administrative, engineering, and architectural planning as well as for supervising the construction work.

Present Status of Forest Improvements

The forest-improvement system on Federal lands is estimated to be about 40 percent complete. The existing improvements serving all forest lands have never been closely inventoried. Fairly accurate figures are available, however, for the various classes of reserved Federal lands and for some State forests. The information on improvements on the unreserved public domain and other smaller Federal properties is less accurate, and few reliable data are available for local government and private holdings.

The planning done for the reserved Federal lands provides an accurate measure of the ratio of existing and required improvements on these lands. From this, with such data as are available, the estimates can be projected across other Federal forest lands, State property, large private holdings, and on through small wood lots. Account is taken of the primary land-use policy and average size of individual properties in each ownership class. Recognition is given to the fact that the intensity of improvements for the administration and management of reserved Federal lands applies in diminishing ratio per unit of area to smaller holdings until for farm wood lots the structural improvements needed for forest management cease to be important factors. In this way, starting with accurate data for managed Federal lands and weighing all available information, estimates for all forest lands have been prepared that are believed to reflect the present situation. Better estimates can be made later as progress is made in planning.

The existing improvement program as a whole is entirely insufficient for present-day, not to mention future, requirements. It is inadequately financed for both nonrecurrent construction work and recurrent maintenance. On reserved Federal lands, at the pesent rate of construction at least 50 years will be required to complete the planned improvements. On the unreserved public domain and private forest lands the program on the average is progressing even more slowly.

Improvement Planning

The procedure and technic developed by Federal administrative agencies for determination of requirements for improvements and communication systems is based on fundamental decisions concerning land use. The forest resources such as timber, forage, recreation, water, and minerals are carefully inventoried and, insofar as practicable for areas supplying several resources, plans provide for multiple use of all on a long-term basis for the benefit of the maximum number of people. At times, of course, areas must be set aside primarily for one use, as in the case of a water reservoir which eliminates other uses through inundation of the land. In such a case, however, important recreation values may also be created by the artificial lake.

From the basic forest-land-use and management plans the required improvements are determined. These are usually indicated on maps and tabulations. Costs are estimated, and priorities are assigned consistent with management plans, urgency of need, probable appropriations, and other considerations that bear on the case in question. These plans and priority lists form the basis for allotment of money as funds become available.

Each improvement is planned to facilitate the conduct of public business and the work to be done, whatever it is. Buildings and other structures are functional in design and at the same time architecturally in harmony with local surroundings. Materials and workmanship are selected to provide the required facilities at the lowest average annual expense, considering first cost, estimated life, and maintenance.

State forest lands are for the most part managed in accordance with a fixed general policy. While the details of planning procedure for improvement systems on these areas vary greatly, different purposes of land management largely determine the intensity and types of improvements required.

Little specific information is available on the planning methods used by private corporations and individuals controlling forest lands. The procedure is known to vary widely, from intensive investigation by some large owners to no planning at all.

There is an evident need for the development and adoption of more systematic, uniform planning methods for all forest lands.

Program of New Construction

Table 25 indicates the volume of work in man-months required to complete the long-range construction program for general or multiple-purpose improvements.

The estimates of employment opportunity, table 26, for this nonrecurrent work are based on efficient conduct of work during the favorable construction season. In Northern States, especially at high elevations, winter construction is not generally practicable. Some off-season construction could be carried on at moderate increase in cost, but this should be avoided as a general rule and winter employment, where essential, should be provided on other projects.

TABLE 25.—*Estimate of man-months of labor required for construction of additional improvements and communication systems to serve forest lands* [1]

[In 1,000 man-months]

Region	All Federal forests	State forests	Private forests	Total
Northeast	11.0	13.2	85.7	109.9
Central	12.1	.8	48.2	61.1
Lake	84.2	61.7	101.9	247.8
South	71.0	3.1	234.0	308.1
Columbia River Basin	209.7	6.3	48.5	264.5
California	92.7	.2	66.0	158.9
Southern Rocky Mountain	245.6	1.0	35.5	282.1
Plains	2.1		178.4	180.5
Total	728.4	86.3	798.2	1,612.9

[1] Nonrecurrent work only; includes betterment of existing structures

TABLE 26.—*Estimates of kinds of labor required for construction of additional improvements and communication systems* [1]

[In 1,000 man-months]

Region	Laborers	Semi-skilled trades	Skilled trades	Helpers or apprentices	Draftsmen, surveyors, timekeepers, clerks	Superintendents
Northeast	3.3	2.1	2.8	1.6	0.5	0.5
Central	3.6	2.5	3.0	1.8	.6	.6
Lake	25.2	16.8	21.1	12.6	4.2	4.2
South	21.3	14.2	17.8	10.7	3.6	3.6
Columbia River Basin	62.9	42.0	52.4	31.3	10.6	10.6
California	27.8	18.6	23.1	13.9	4.6	4.7
Southern Rocky Mountain	73.6	49.1	61.3	36.8	12.4	12.4
Plains	.6	.4	.5	.3	.1	.1
Total	218.3	145.7	182.0	109.0	36.6	36.7
Percent of all labor required	30	20	25	15	5	5

[1] Reserved Federal forest lands only.

For orderly, economical progress it would be ideal if regular funds could be provided at a uniform rate sufficient to complete the work in 20 to 25 years. This basic program could, of course, readily be speeded up for relief of unemployment. Much of the construction is urgently needed now, however, and the remainder should be timed to become available as required by the progress of forest-management activities. The program should not, therefore, be slowed down too much at any time. It is desirable that regular budgets provide for an annual construction program on Federal lands of at least 4 percent of the present uncompleted portion.

In recent years considerable construction was accomplished from camps by the Civilian Conservation Corps. This procedure can be continued whenever the services of such agencies are available. However, the structures to be built are usually small, and most of the work to be done can be accomplished by small groups of laborers and tradesmen living close to the projects.

The total of more than 728,000 man-months of labor (table 25) for the reserved Federal lands is about 45 percent of the program estimated to be needed for all forest lands. The distribution of the skills required for the whole program would be about the same as indicated by this estimate.

Financial Responsibility

General forest improvements and communication systems are constructed to facilitate the management of areas that are ordinarily well defined and that do not usually extend beyond property or administrative boundaries. Responsibility for financing is, therefore, ordinarily that of the administering agency or landowner. The Federal Government should continue to finance improvements on Federal forest lands. Local governments and private forest owners should ultimately pay the costs of improvements on their own property, but in some instances Federal loans or other cooperation may be extended.

Private improvements of commercial nature, such as sawmills, pulp mills, and wood-using plants of various kinds, should be financed by the owners. Government participation should be limited to loans with security and provision for payment consistent with recognized business standards.

As a general rule, expenditure of public funds for construction is only justified if responsibility is definitely fixed for financing maintenance expense. This point is important in connection with projects that may be undertaken as a part of an unemployment-relief program. Ordinarily the agency providing the funds should obtain positive understanding that the benefiting agency definitely plans to and is financially able to keep improvements properly maintained.

Basis of Evaluation

Experience in the management of Federal forest lands indicates that an expenditure of 75 to 80 cents an acre will provide the required general improvements and is a justifiable cost. The new construction included in the estimates of the work to be done in this chapter will cost, on the average, about 45 cents an acre.

It must be remembered that the required improvements are facilitating details of a Nation-wide program for forest-land use. If major forest programs are undertaken, then any reasonable requirement for office quarters, other buildings, telephone systems, and the like, becomes an integral part of the larger project.

Technical Soundness.—Improvement plans and designs have been developed which have been proven by experience to be economical for the functions each serves. Technical soundness for structural design, architecture, materials, and workmanship is subject to accurate check by recognized general standards supplemented by years of experience in the construction, maintenance, and use of forest improvements under all kinds of local conditions. The gauges for measuring technical soundness are well established and they should be applied to all proposed projects.

Cost-Benefit Evaluation.—A few improvements can easily be weighed on the self-liquidating scale, as for example, a dwelling which is to be furnished on a rental basis to a forest administrator. In general, however, the evaluation of improvements and communication systems for forest lands does not lend itself to ordinary cost-benefit ratio analyses.

A lookout tower may be instrumental in prompt discovery of a forest fire, which if not discovered in time would have caused millions of dollars of damage. In the prevention of such damage, however, all the men and facilities used, the roads, the telephone lines, the fire equipment, etc., should share the credit and at this time no procedure for determining the amount that can be credited to the tower has been worked out. The benefits derived from general administrative buildings such as offices in remote forest areas where rental is out of the question are even more difficult to evaluate in dollars. As has been mentioned before, these general improvements are necessary facilities for a broad forest program for which the cost-benefit ratio for the national welfare as a whole is the important consideration.

On the credit side is the employment furnished workers. People living on or near forest lands receive in the aggregate substantial sums for labor, building materials, tools, and equipment used in the construction and maintenance of improvements. Important intangible values accrue from well-designed, business-like structures that command the respect of the public.

Priorities.—The improvement program is so far behind that many projects are urgently needed and priorities would not be much of a problem even for an expanded program. The priority for some improvements is determined as the need for them develops with the progress of land use and management plans.

For any normal annual program the administrators consider the factors applicable at that time and decide on allotments to the most urgently needed projects. Status of management plans and all other considerations are weighed; as for example, the need for suitable quarters to take the place of inadequate rented facilities. The priority list should be a flexible one, subject to revision as required to meet changing conditions or alterations in management plans.

Timber Resource Development

Introduction and Summary

Fire protection is only the first step in the full development of our forest-land resource. Nor can natural processes be depended upon to complete the job, for nature requires centuries to attain the goal that man must reach in a generation or two. Man must adapt the processes of nature to a greatly accelerated program, by substituting his skill and labor for many of the time-consuming elements of nature's methods.

Forest research has been working out means to repair the damage incurred during the period of exploitation of our virgin timber and subsequent neglect and deterioration of millions of acres of our forest lands; to restore denuded areas to tree growth; to manage natural regrowth on cut-over lands so as to avoid understocked or overstocked stands; to reduce the dominance of unprofitable species or individuals and the proportion of low-grade timber; to utilize the forest so as to attain a working balance between optimum yields and most favorable conditions for new growth; and to hold attacks of disease and insects to a tolerable minimum. By these means it is possible greatly to increase the yield from forest lands of salable timber and of watershed, wildlife, and recreational services. The effective application of these measures over the vast area involved demands a technically sound and balanced long-range program flexible enough to meet sudden unforeseen developments that threaten the forest, and to absorb surplus labor.

Public Works Aspects.—Several types of activities in the field of timber-resource development are suitable for public work projects. These include planting of denuded or sparsely productive lands; cultural work to improve composition, growth rate, and quality of growing forest crops; and protection of the forest from the ravages of destructive insect pests and disease. In many regions a large local population lives close to the forests, and needs part-time employment. Local people are accustomed to the type of work proposed. The jobs require only simple tools and equipment. Much of the proposed work is seasonal but inasmuch as most areas require several types of work, the composite whole can be spread over most of the year. Forest planting is limited to rather short seasons, usually spring and fall, except in the South where planting can often be done through the winter. Forest-stand improvement work, generally speaking, can be done at any season, although some phases of it are done more effectively in summer and fall. White pine blister rust control can

be carried on only during 6 to 8 months when currant and gooseberry bushes are in leaf and can be readily detected.

Public Works Accomplishments.—Notable contributions have been made by the CCC in the timber-resource development field. In round figures the CCC since 1933 has planted 2 million acres of forest lands; has done forest-stand improvement work on nearly 4 million acres; has worked more than 5 million man-days in forest nurseries; has accomplished insect-pest control on 12 million acres; and has carried on tree and plant disease control on 8 million acres. The WPA has accomplished material amounts of similar work.

Proposed Program.—Briefly the components of the proposed program are:

1. *Forest planting.*—A program covering 25 years and 32 million acres, which will require some 3,235,000 man-months of work. More than four-fifths of the planting would be done on lands east of the Great Plains.
2. *Forest-stand improvement.*—A program covering 65 million acres during the next 25 years, largely in second-growth timber near timber-manufacturing centers. The major portion will be in the Lake States, the South, and the East. Labor requirements will be approximately 6,500,000 man-months.
3. *Protection from insects and disease.*—Currently, white pine blister rust is the most serious disease that can be held in check by organized control measures. The area requiring protection is about 29 million acres, but the control work still to be done amounts to 42 million acres, because some areas have to be reworked one or more times. This will require 566,000 man-months of labor. The work to be done is about equally divided between East and West, but work in the West is more urgent. Control of other diseases and of insects frequently presents serious problems, but the outbreaks are unpredictable. Emergency control measures must be employed promptly as outbreaks occur.

The urgency of particular needs of any locality will govern priorities but, generally speaking, forest-stand improvement will yield returns earlier than forest planting. The treatment of forest disease and insect outbreaks, even though often performed in relatively inaccessible western forests remote from centers of population, deserves high priority because it commonly protects merchantable timber waiting to be cut.

Since the objective of timber-resource development is continuous production of usable timber crops, it follows that the program proposed herein is intimately related to the harvesting, marketing, and utilization of forest products. Prerequisite to satisfactory forest management is a transportation network such as has been included in the forest transportation program.

Forest Planting

What Forest Planting Is and Why Needed.—Forest planting, the establishment of forest stands by planting seed or plants, is accomplished predominantly by planting nursery-grown seedlings or transplants.

Under proper management, most forest stands can be regenerated satisfactorily and more cheaply by natural means than by planting. Even without management, many areas have restocked naturally. Planting is desirable where established natural reproduction is sparse, irregular, or of poor species, or where natural regeneration is slow. There are cases where planting is a valuable time-saver—for example, where cut-over slopes would erode if not promptly restocked, or where short-rotation, high-value products are grown. This section treats of all forest planting, whether for timber production or for other purposes, except that involved in the Shelterbelt Project. There is 77,000,000 acres of forest land on a large part of which planting is needed if adequate timber production and other benefits of forest cover are to be assured.

Forest planting is a technical job, not merely growing small trees or seedlings and setting them in holes in the ground. It involves technical knowledge of site quality of areas to be planted—the factors of moisture, temperature, soil, etc.; the existing or prospective cover, such as grass, weeds, or brush, and its probable effect in competition with planted trees; the choice of species suited to the area and yielding the most desirable products; source of seed; how to produce the best planting stock; planting technics; and finally planting itself, which may involve site preparation and measures to protect the plantations.

There are about 125 large public nurseries which produce some half billion trees annually. The Forest Service has 26 permanent nurseries with a production of 150 million trees a year. The output could be doubled within 5 years. Eleven Shelterbelt Project nurseries (mostly leased) are producing 40 million trees annually. Forty-two States with some Federal cooperation under the Clarke-McNary Law operate more than 60 nurseries and produce some 195 million trees, of which 87½ million were sold at cost or less to farmers and other small landowners in 1940. The Soil Conservation Service with 26 nurseries produces about 110 million trees, the TVA about 25 million, the Office of Indian Affairs some 2½ million, and various other agencies smaller amounts.

Some commercial nurseries produce stock for forest planting and could grow much more, given a more

assured market. Some Federal and State agencies purchase part of their stock from these sources; for example, most of the hardwood stock distributed in Nebraska under the Clarke-McNary Law.

Public Works Opportunities—Labor represents about 80 percent of the cost of forest planting. Simple hand tools suffice, except for nursery equipment and the plows and tractors needed for ground preparation on some areas.

Planting furnishes seasonal and part-time employment. Digging and sorting planting stock in the nursery, transporting it to planting sites, and field planting are done in fall, winter, or spring (depending mainly on latitude), which are "off seasons" in farming and many other employment fields. Nursery work reaches a peak in late spring with seedbed preparation, seed sowing, and transplanting.

Forest planting cannot be greatly expanded and contracted in less than a 2- to 5-year cycle, because of time required to collect seed and grow the young trees to the needed size. Generally speaking, younger stock can be field-planted more successfully in the South than in the North. Attention also must be given to the source of seed, age of stock used, and other nursery problems such as disease prevention, watering, and maintenance of soil fertility. Expansion of nursery production, despite the availability of suitable soils and sites, involves much more than extending nursery boundaries to take in more land and sowing more seed on the new land.

Under some conditions direct seeding is a more expeditious method of artificial regeneration than planting. Although large-scale direct seeding was discontinued by the Forest Service in 1912 because of generally unsatisfactory results, recent experiments indicate that it can succeed under some conditions, with improved technics. It has one great advantage—seed can be collected in the fall, stratified over winter, and planted the following spring, whereas to produce planting stock requires at least a year and usually longer. Costs vary greatly with cost of seed, ground preparation, rodent control, and the like, but are generally somewhat less than for planting.

Planting Progress to Date.—Forest planting in the United States was sporadic until recent years. Some of the earliest extensive planting was brought about by the Federal Timber Culture Act of March 3, 1873 (17 Stat. L., p. 605, Rev. Stat. of 1878, sec. 2464), under which forest planting and cultivation of the trees was one means of proving up on a prairie homestead claim. As a result, Nebraska, curiously enough, shows the third largest acreage planted in the United States. In 1911 the Forest Service undertook a short-term ambitious program of seeding and planting on the national forests, the unsuccessful outcome of which proved the need for planting research, and resulted in the much sounder planting program of today.

A number of States have had planting programs, varying in intensity and with the ups and downs of appropriations. New York and Pennsylvania started to plant State lands about 1900, and New York began a 20-year program of acquiring and planting abandoned farm land in 1928–29. In the first 7 years the State had planted more than 100,000 acres of acquired land. New York also has planted extensively on other State lands, and had to its credit by 1940 more than 200,000 acres of successful plantations. In Michigan by the same year plantations on State lands had reached 175,000 acres. With a total of about 575,000 acres successfully planted by all States, however, it is obvious that most of the others have planted only meagerly.

The Soil Conservation Service began planting in 1934 and by 1940 had reached some 407,000 acres. The TVA has planted 61,000 acres of watershed and eroding lands.

Private planting has accelerated in recent years, owing in part, no doubt, to such factors as public aid through the Clarke-McNary Act of 1924 (43 Stat. 653), AAA benefit payments, Soil Conservation Districts, and interest in planting stimulated by the CCC and other conservation activities.

Up to 1940, all agencies had established only about 3½ million acres (table 28) of successful plantations, nearly half on public lands; whereas approximately 80 percent of the 32 million acres needing planting in the near future (table 27) is now in private ownership. Of the plantations on private lands 81 percent is on farms.

Recommended Planting Program.—A 32-million-acre forest planting program is recommended (table 28), to cover the most urgent needs. This goal should be attained within 25 years. It includes only about 40 percent of the poorly restocking and nonrestocking lands. This program can be prosecuted in large part as public works, subject to the qualifications herein stated—i. e., factors affecting expansion, continuity of operation, financial responsibility, and ownership status.

Existing public nurseries can produce about ½ billion trees annually. Many can be expanded and some stock can be obtained from commercial nurseries, but additional nurseries will be needed to supply the planting stock required for the program recommended. If 32 million acres is to be planted in 25 years, the average annual stock requirements will exceed 1¼ billion trees—nearly three times the current output of public nurseries. It might be practicable to double nursery production in 5 years, and increase to 2 billion trees an-

nually, during the next 5. This should provide all the planting stock needed to accomplish the program in 25 years, with a safe margin for unforeseen losses.

TABLE 27.—*Estimated area of successful forest planting, through 1939*

[In 1,000 acres]

Region	All Federal lands	State, county, municipal lands	Private lands	All areas
Northeast	22	408	354	784
Central	36	33	273	342
Lake	377	240	74	691
South	288	22	469	779
Columbia River Basin	137	15	28	180
California	7	2	51	60
Southern Rocky Mountain	35		13	48
Plains	14	2	526	542
Total	916	722	1,788	3,426

TABLE 28.—*25-year forest planting program, by ownership class*

[In 1,000 acres]

Region	All Federal lands	State, county, municipal lands	Private lands	All areas
Northeast	50	500	3,300	3,850
Central	200		2,400	2,600
Lake	1,600	2,100	5,100	8,800
South	400	200	11,400	12,000
Columbia River Basin	550	500	2,200	3,250
California	150	100	500	750
Southern Rocky Mountain	400		100	500
Plains	150	100		[1] 250
Total	3,500	3,500	25,000	32,000

[1] Does not include prairie-plains or so-called shelterbelt planting. See section on Shelterbelt Project.

Forest lands with the best timber and nearest to market were generally cut cleanest. These now make up a large part of the poor and nonrestocked acreage. Where timber production is the primary consideration, such lands should generally have high priority for planting.

Federal forests, as a class, are managed the most intensively at present, but on thousands of acres far from market planting for timber production alone is not economically justified. Industrial concerns own much of the most productive and accessible land; 16 million acres of their land is included in the program, in contrast to the 284,000 acres planted to date. Farm woodlands are generally above average in potential productivity. A large part of the products can be used on the farms, and markets for what is sold are usually much nearer than is the case with nonfarm forest lands. Residence enables farmers to give their forest a high degree of protection and management. Natural regeneration by selective cutting and other means can be favored, but 9 million acres of planting is included in the program.

Estimated Employment and Costs.—Only a general idea can be given regarding the amount of employment provided by this program (table 29). Many variables affect the estimates, such as: accessibility of planting sites; existing ground cover, need for ground preparation, protection against insects and animals, the rate and effect of public acquisition, emphasis on unemployment relief, future price levels, wages, and the public contribution pattern. An important factor is the number of trees planted per acre—which may vary from 500 to 1,800, but averages about 1,000. The estimated average cost ranges from $7.00 to $15.00 an acre for various regions. The range by individual projects will be even wider. A useful measure is the estimated man-months of employment that the program will afford.

TABLE 29.—*Volume of work provided by planting program* [1]

Region	Acreage	Approximate employment
	1,000 acres	*1,000 man-months*
Northeast	3,850	550
Central	2,600	290
Lake	8,800	1,000
South	12,000	900
Columbia River Basin	3,250	300
California	750	95
Southern Rocky Mountain	500	70
Plains	250	30
Total	32,000	3,235

[1] Includes nursery production, transportation of stock and planting crews, ground preparation, planting, and supervision.

Continuity of Effort.—Nursery production is the key to forest planting. Continuity of nursery operation is essential, and provision must be made for planting the trees as they grow to field-planting size. It is useless to start growing trees without reasonable assurance that they can be planted, 2 to 5 years later. Although both nursery work and planting are well suited to public works, they cannot be handled entirely by emergency funds. A backlog of regular appropriations is essential.

Financial Responsibility.—The Federal Government undoubtedly must bear the entire cost on Federal lands. Similarly, the State governments should bear the cost on State lands, except for such aid as may be furnished by the WPA, or in like pattern. County and municipal agencies should bear the cost on their own lands, with aid from the States or from the Federal Government comparable to that furnished States.

The Department of Agriculture has recommended that private owners continue to bear the primary cost on their lands, with Federal aid as follows:

1. Farmer landowners should be furnished more planting stock at cost and should continue to receive AAA benefit payments.
2. Nonfarmer landowners also should be furnished planting stock at cost. This would involve amendment of the Clarke-McNary Act, which does not now provide this aid for nonfarmer owners.

Forest-Stand Improvement

Definition and Scope.—Forest-stand improvement denotes cultural work necessary to better the composition, quality, and growth rate of any forest stand, from the sapling to the saw-timber stage.

When we had seemingly unlimited quantities of virgin timber, scant attention was devoted to the regrowth of satisfactory timber crops. That day is past. If we are to grow the timber that we need, our forests must be tended carefully. Particularly on forest lands under intensive management existing stands must be improved so that maximum timber crops can be grown in the shortest practicable time. Intensive forestry, like intensive agriculture, requires considerable expenditure of labor under competent technical supervision while the crop is being grown.

Unsystematic cutting and abuse have resulted in millions of acres of young stands containing much material that should be removed, although too small or too poor to be marketable. Many stands include tree species of greatly differing value, some of which are "forest weeds," which may grow so rapidly as to overtop and suppress more desirable neighbors. Deformed or defective individual trees of valuable species should be removed. Natural stands often become so dense that satisfactory growth is impossible. Weeding and thinning, to insure proper growing conditions for the young trees that show the greatest promise, usually can be carried on in young stands at comparatively low cost; stems are small and the workers can progress rapidly. Pruning the limbs from the lower portion of the trunks of selected crop trees to accelerate greatly the time when clear lumber will be produced is often a desirable practice.

Other types of work, such as some thinnings, release, improvement, and salvage cuttings may yield sufficient marketable products (fuel wood, pulpwood, sawlogs, etc.) to offset part or all of the cost of doing the work. Relatively little forest-stand improvement that can be paid for by sale of products has been included in the proposed prgram for public works (table 30), because much of it can be accomplished by commercial timber operations.

This is well illustrated by cutting practices on managed public forest lands—national forests, O. and C. lands, Indian forests, State forests, etc.—which improve the composition and growth prospects of the areas cut over. Similar results obtain on private forest lands where forestry is practiced. Thus there is an ever-increasing opportunity for real forest-stand improvement, on both public and private lands, through the extension of better cutting practices.

The Opportunity for Public Works.—Since forest-stand improvement is an essential feature of growing timber crops, comparable to the cultural activities on farm land, it is a regular activity of the public (Federal and State) agencies that manage forest lands for timber production. Surveys and plans for work on specific areas can be prepared quickly and simply and, with the adequate technical supervision which these agencies are prepared to give, can be translated into action programs which will employ large numbers of laborers.

Most of the work is done by hand. Axes, saws, and brush hooks constitute the principal equipment needed. Generally speaking, any season of the year is suitable.

Unskilled labor can sometimes be employed extensively. Logically, however, this is a job for rural residents skilled in the use of the tools required and familiar with the often rugged and difficult terrain. On the managed public forests, excellent results have been attained with crews of experienced local woodsmen.

Forest-stand improvement is thus an ideal job for periods of slack employment in other forest industries, as when logging jobs and sawmills are operating intermittently or not at all. Not only can it be started on short notice but it can be stopped as quickly. If adequate provisions are made for planning and technical supervision it can employ large numbers of laborers for short periods.

Proposed Program.—In forest-stand improvement a start has been made, and many satisfactory technics have been developed, but vast quantities of this useful and necessary work remain to be done. About 3.9 million acres of managed Federal and other public forest land has been covered by organized crews of laborers, including relief workers such as CCC and WPA.

Forests are dynamic, not static. Forest conditions change greatly in as little as 5 to 10 years. As it requires 50 to 200 years to mature a crop of timber, any prediction of what forest-stand improvement is needed must be greatly generalized. Fires, storms, insect and disease outbreaks, and continued destructive cutting may increase the need for such work. A generalized program is presented in table 30. It is indicative of the progress that should be made in the next 25 years, but it is not to be considered as covering total needs.

Most improvement work will be done on lands that are managed intensively, but certain measures are justified on lands managed on a more extensive basis. Controlling factors are inherent qualities of species being grown, rate of growth, and markets, particularly for small-sized products such as fuel wood, pulpwood, and posts. These vary by regions. Table 30 shows that three-fourths of the program falls in three regions.

TABLE 30.—*Proposed 25-year forest-stand-improvement program*

[In 1,000 acres]

Region	All Federal lands	State, county, municipal lands	Private lands	All areas
Northeast	300	600	8,500	9,400
Central	500	300	4,150	4,950
Lake	3,500	4,000	6,700	14,200
South	1,100	300	25,150	26,550
Columbia River Basin	3,200	400	3,500	7,100
California	700	50	600	1,350
Southern Rocky Mountain	600	50	100	750
Plains	60	40	600	700
Total	9,960	5,740	49,300	65,000

Regional Aspects.—The South, with 45 percent of our forest land, is allotted the largest program. The South grows a number of important general-utility pine and hardwood species, it has favorable growing conditions, and it has increasing outlets for pulpwood. Past clear cutting and turpentining have resulted in areas of second growth that need thinning, others that need pruning. On the other hand, inadequate fire protection and improper methods of cutting have produced extensive areas where reproduction and young growth should be released from an overstory of "wolf trees." Rapid growth favors the application of these measures because of relatively quick returns.

The Lake States, with the next largest program, have extensive second-growth cut-over lands where the production rate will remain low for years unless aided by stand improvement. Although growing conditions are less favorable than in the South, diversified markets nearby and high stumpage values favor treatment. This region can produce quality hardwoods and white pine. There are outlets for cordwood through the paper, distillation, and other industries. With a cold climate and fairly heavy population density there is a large fuel-wood consumption.

The highly industrialized and densely populated Northeast affords a fine market for home-grown forest products, which justifies and makes profitable cultural measures such as weeding young hardwood and pruning young pine stands. The timber salvaged after the New England hurricane was 70 percent low-value No. 3 logs; it is estimated that earlier adequate pruning would have produced 70 percent No. 1 and No. 2 logs worth from $2 to $6 more per thousand board feet.

The Pacific Northwest is another region where growth is rapid and forest-stand improvement will pay high dividends in future returns.

Even where extensive management prevails, stand-improvement measures have a place. Throughout much of its range ponderosa pine grows slowly and is subject to mistletoe and red rot. Sanitation measures, pruning of crop trees, and thinning of overdense groups and stands are appropriate management measures.

Cost.—Because of the wide variety of work and of working conditions represented in the program, it is impracticable to estimate other than man-month costs. Weeding in very young stands or plantation-release work may be at the rate of 3 to 4 acres per man-day, but salvage cutting may take 6 to 8 man-days per acre. Studies on the Harvard Forest, Petersham, Massachusetts, showed that for northern hardwood stands on good sites an investment in one or more treatments of as much as 3½ man-days per acre (total about $30 an acre including labor at $0.65 an hour and competent technical supervision), would be amply justified by the improved quality of the yield. In some southern pine stands worth-while results have been obtained by such simple work as girdling worthless hardwood "wolf trees" at a cost of $0.75 to $1.50 an acre.

Different portions of a tract of restocked cut-over land may require weeding, thinning, release cutting, pruning, and some salvage cutting. Thus it may be possible under one project to place a considerable area of forest land in good condition for future growth, and at the same time to salvage some products that otherwise would be lost. Usually on any sizable area of forest land there are several of these jobs to be done. The average work required per acre treated should not exceed 1 to 3 man-days. It may be assumed, therefore, that the work involved in the whole forest-stand improvement program can be done at an average rate of 10 acres per man-month, including supervision. The volume of work in each region and for lands in each ownership class may be determined approximately by dividing the figures in Table 30 by 10.

Financial Responsibility.—Forest-stand improvement is a capital investment. Returns usually will be deferred, although certain measures may produce immediate vendible products which will partially offset the cost of the work. The public interest in future timber supplies may be promoted by financial aid in protection, care, and management of forest lands.

On Federal lands, there is no question that the Federal Government should bear the total cost of stand improvement. On State, county, and municipal lands the primary assumption of financial responsibility must be by the owning agency. Federal assistance is also justifiable, provided the land is managed in accordance with good forest practices.

On private lands, the financial responsibility for stand improvement rests on the owners, but public interest demands Federal and State aid in developing, demonstrating, and teaching sound practices. Farm woodlands share in the general farm program. The Cooperative Farm Forestry Act (50 Stat. 188; 16 U. S. C. 5686) authorizes the Secretary of Agriculture

"to advise farmers regarding the establishment, protection, and management of farm forests. * * *" AAA benefit payments are also made for the protection and improvement of the farm woods.

Prevention and Control of Damage From Disease and Insects.

Why Control Measures Are Necessary.—Never free from disease and insects, forests are susceptible to epidemics of catastrophic proportions which know neither State nor national boundaries. Endemic occurrence of forest diseases and insects must be expected, even in intensively managed forests. Owing to weather conditions and other environmental factors, however, native diseases and insects may assume epidemic proportions and cause widespread losses. Bark beetles in Washington and Oregon in 1931–35 killed nearly as much ponderosa pine as was cut, and 15 times the amount destroyed by fire. There is also the ever-present danger of importing foreign diseases and insects, which frequently have been extraordinarily virulent in their attacks upon our native trees. Chestnut, one of the most valuable hardwoods, was wiped out by blight, and blister rust, a foreign invader, is killing our native species of white pines.

Proper silvicultural measures cannot eliminate insects or disease, but can minimize the damage caused by them. Direct control measures are absolutely necessary to reduce incipient epidemic outbreaks and to suppress epidemics that get away. Insect outbreaks must be detected and treated promptly, if control is to be accomplished at reasonable cost. The regular work of governmental agencies includes disease and insect control on forest lands but there is a real need and opportunity to expand such work. Of the problems now facing us, only the control of white pine blister rust is susceptible of advance programming.

White Pine Blister Rust.—White pine blister rust was introduced into the eastern United States about 1898 and into Vancouver, B. C., in 1910. It has become established in our important commercial white pine areas and is present in 25 States.

Eight native species of white pine are susceptible to this disease. Five occur at high altitudes in the West and are important for scenic, recreational, and watershed values. Each of the other three is the most valuable softwood tree in its commercial range—eastern white pine from Minnesota to New England and southward along the mountains of the East; western white pine in western Montana, northern Idaho, and eastern Washington; sugar pine in California and southern Oregon. The value of the standing timber of these three species is about $350,000,000. There is also a potential future crop in millions of acres of young growth. Their destruction would be a calamity.

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Of vital importance in control work is the fact that the disease cannot spread directly from pine to pine, but must first spread to certain species of Ribes (wild and cultivated currants and gooseberries), its alternate hosts. Further, although it may spread by wind-blown spores to Ribes more than 150 miles away, it seldom can be communicated to pines more than 900 feet from the Ribes host. Control consists of destroying all Ribes within infecting distance of white pine. With the disease present throughout most of the commercial white pine areas, continuous and vigorous control is necessary.

The Ribes bushes are mostly pulled up by hand, although chemical treatments or heavy mechanical equipment is used occasionally. Technical supervision is necessary for scouting, planning, working, and checking, but unskilled laborers are used for the eradication work. Work can be done effectively only when bushes are in leaf—otherwise they are hard to detect.

Most of the control work in the East is done in areas that are near communities, but in the West much of the control zone is in relatively inaccessible rugged country; the work is more arduous and must be done from camps located close to the job. For these reasons, the ideal arrangement is a substantial backlog of regular funds supplemented by equal or greater amounts of emergency funds, so that the work can be planned and carried out regardless of the relative accessibility of the various jobs. This has been done for the past 7 years, although both regular and emergency funds are currently inadequate to prosecute the work as rapidly as it should be done.

Some 29 million acres need protection, of which more than 21 million acres has been worked once and 7 million has been reworked one or more times. In the East, the disease has been effectively checked on 80 percent of the control area, and control has been maintained sufficiently to avert serious losses but each year a considerable acreage requires reworking. In the western white pine region about 75 percent of the control area has been initially protected, and in sugar pine about 30 percent.

There remains 7.6 million acres in need of initial protection. Some areas need to be worked only once, others several times. It is estimated that 16.4 million acres need reworking once, 11.7 million acres a second time, and 5.9 million acres at least a third time. This reworking is necessary because there are Ribes seed, small seedlings, and pieces of roots that cannot be discovered in early workings. Initial eradication plus reworking will amount to the equivalent of about 41,700,000 acres worked once (table 31). The work in the East can be substantially completed in a few years, depending on availability of labor and funds. At the

present slow rate, it will take from 12 to 20 years to complete the initial work in the West.

TABLE 31.—*Areas still to be worked for ribes eradication (initial and rework)*

[In 1,000 acres]

Region	Federal forests		State and Private		Grand total	
	Initial	Total	Initial	Total	Initial	Total [1]
Northeast	1.6	40.0	2,867.1	18,684.4	2,868.7	18,724.4
Lake	150.3	728.6	950.4	4,654.5	1,100.7	5,383.1
Central		4.2	448.8	1,772.8	448.8	1,777.0
South	76.6	1,606.3	183.8	4,112.8	260.4	5,719.1
Columbia River Basin	604.7	2,776.5	365.2	1,969.5	969.9	4,746.0
California	907.2	2,425.3	678.8	1,904.6	1,586.0	4,329.9
Southern Rocky Mountain	417.3	1,012.1			417.3	1,012.1
Total	2,157.7	8,593.0	5,494.1	33,098.6	7,651.8	41,691.6

[1] This total is made up of 7,651,800 acres of initial eradication, 4,679,500 acres for 1 reworking, 5,871,900 acres for 2 reworkings, and 5,872,200 for 3 or more reworkings.

The cost of destroying Ribes has varied with such factors as accessibility of control areas, number of Ribes plants, character of ground cover, and roughness of terrain. It has ranged from 50 cents to $7 an acre, of which 80 percent is for wages. The average cost for initial treatment is about $1 an acre in the East and $5.50 or more in the West. The cost for second and third workings should average less than that of the initial eradication. It is estimated that the remaining initial treatment and reworking will require approximately 566,000 man-months of labor, of which roughly 56 percent will be in the West and 44 percent in the East. The volume of work by regions is as follows:

Region	*Man-months*
Northeast	149,000
Lake	66,000
Central	22,000
South	10,000
Columbia River Basin	180,000
California	123,000
Southern Rocky Mountain	16,000
	566,000

The work in the West is extremely urgent, because of the economic importance of the white pines there. Studies show that if initial work is not completed in 3 years in the northern Rockies and 9 years in the sugar-pine region, extensive areas of reproduction—forests of the future—will be destroyed.

Bark Beetles.—The Black Hills beetle, mountain pine beetle, western pine beetle, and southern pine beetle are most destructive of the bark beetles. Occasionally, epidemics of these beetles destroy large quantities of timber over wide areas. Other species cause gradual losses over long periods.

Direct control usually involves locating and marking infested trees, which are then felled, peeled, and burned. Skilled woodsmen are ideally suited to this work, which is usually done in fall and spring, and also in winter if snowfall is not too heavy.

Such measures are for protection of timber that cannot be utilized immediately. As forests are put under management the problem will resolve itself into one of prevention rather than control. A promising preventive method is being developed in the ponderosa-pine type in California and Oregon. For the past few years, under the technical direction of the Bureau of Entomology and Plant Quarantine, bark-beetle-susceptible trees have been marked and removed, prior to attack, in experimental logging operations. The timber is utilized, so the operation is a combined prevention and salvage measure.

This "insect-risk selection" system could be applied on 15 million acres of western forests. Extensive losses would be prevented. Timber would be used which otherwise will be wasted. Virgin stands would be less liable to decimating epidemics because the trees most susceptible to attack would be removed before being attacked. Construction of some utilization roads (see Forest Transportation) would be necessary. Logging costs would average $12 to $18 an acre, largely recoverable by sale of logs.

It is impossible to set forth a program of future work in bark-beetle control. Weather conditions and other factors influence increases in insect populations that necessitate immediate action and it is seldom possible to predict needs more than 6 months in advance.

Experience has shown that the cost of control work averages about $4 per treated tree. This is roughly equivalent to one man-day, including all costs of surveying the extent of the infestation, locating the trees to be treated, establishing camps (practically all of the work in the West must be done from camps), supervising the work, treating the trees, and checking the work.

Gypsy Moth.—The gypsy moth is the most important of several foreign insects that damage eastern second-growth stands. Although recent timber losses have been less serious than those of 30 years ago, there is constant threat of epidemic outbreaks where control measures are neglected.

Direct control consists of spraying the foliage with arsenicals to kill the young caterpillars, and creosoting the egg clusters during the winter. In an effort to prevent the spread of the gypsy moth westward a barrier zone along the New York, Vermont, Massachusetts, and Connecticut boundary lines was established some 20 years ago. The plan was to treat all infestations in this zone. However, heavy infestations have developed west of the zone in southern New York, in the vicinity of the Catskills, in northeastern Pennsylvania, and in New Jersey. Some $50,000,000 has been spent in control by Federal and State agencies.

Foresters are beginning to regard control as more of a silvicultural problem. It appears that removal of the favored food trees will prevent practically all damage. This offers a large field for silvicultural work. The method has already been applied in some forests in Massachusetts.

Most of the area needing treatment is in private ownership and less than 10 percent is in State ownership. The areas on which this specialized type of work should be done have been included in the program of Forest Stand Improvement (table 30).

Other Diseases and Insect Pests.—Many other diseases and insect pests reduce the quality and yield of the forests. They include diseases such as wood-rotting fungi, leaf diseases, rusts, canker, and mistletoe, and insects such as white pine weevil, locust borer, tip moths, and bud-worms. Normally endemic, they cannot be eliminated from the forest. When they attain epidemic proportions prompt control is necessary. Most of them can be kept in check by silviculture and fire protection measures. Under intensive management timber crops are harvested before there are serious losses from disease.

Rodents.—Rodents cause but little loss under normal conditions. Excessive local increases in populations of such animals as the snowshoe hare and the porcupine, however, necessitate control in order to avoid severe damage to the forest. Particularly in forest plantations in brushy areas, snowshoe hares and rabbits sometimes cause extensive loss. Jackrabbits are a major hazard to Plains shelterbelts.

Ground squirrels and mice sometimes must be controlled to prevent destruction of tree seed. These animals are often responsible for the failure of natural reproduction and direct seeding. Pocket gophers are also serious in some localities. On the Nebraska National Forest, for example, it has been necessary to poison them over large areas in order to prevent total loss of planted trees.

Control measures for various rodents have been developed by the Fish and Wildlife Service to alleviate extreme local conditions. Poison must be used with care in rodent control to avoid killing valuable wildlife.

Public-Works Aspects.—Prevention and control of damage to forests from diseases, insects, and animals is an integral part of forest management and should be carried on currently. Certain kinds of work that have been discussed, such as rendering the forest less susceptible to attack, checking of epidemics, and salvage of damaged trees, are well suited for inclusion in long-range works programs, although only white pine blister rust-control projects can be planned definitely. Problems of control of other pests should be considered as they arise. The CCC and WPA made possible a large expansion of control work on blister rust, insects, and rodents. Future plans could well follow a similar pattern—a backlog of regular funds supplemented by emergency funds as needed. Prompt action is essential to control emergency outbreaks.

Financial Responsibility.—Insects and diseases, like fire, are not limited by property lines. As in the case of fire, the public has a distinct responsibility for sharing in the cost of protecting the forest. On Federal lands, the Federal Government should stand the entire cost. As for State and private lands, Federal and State quarantines are well organized, and funds are frequently provided for epidemics that have reached large proportions. Since diseases and insects do not respect State lines, considerable Federal contributions are justified. Private owners should undertake much of the sanitation work, particularly silvicultural measures needed to reduce the normal insect and disease losses on their lands. In this work they should receive suitable technical guidance from the Federal and State Governments.

Evaluation of Timber Resource Development Projects

Major Objective—More and Better Timber.—Given adequate protection from fire and reasonable restrictions on grazing and lumbering, the natural forest cover will generally protect the soil from erosion, maintain favorable watershed conditions, serve as a satisfactory habitat for wildlife, and preserve scenic and recreational values. It is not necessary that the trees be of kinds valuable for timber or that they be straight and free from defect. Unless so concentrated and on such a large scale as to make large openings or seriously reduce the density of the forest cover, attacks of forest insects and diseases will not materially impair these noncommercial values.

Planting will be necessary to safeguard these values in many instances where the forest cover has been destroyed and where it will not be restored promptly by natural means. The major objective of most forest planting, however, and practically all stand-improvement work and disease and insect control, is the production of usable timber.

Timber development and management projects other than planting, therefore, will find their justification mainly in the extent to which they will result in more and better timber products from the land in question. Justification for many planting projects will lie mainly in timber production; for others, in other forest values; and for still others, in a combination of timber production and other benefits.

Limitations of Benefit-Cost Ratio as Criterion.—Growing merchantable timber from the seed takes a long time. Pulpwood can be grown in as few as 20 years in some regions, but 200 years or more may be

required to produce the large, clear timber that is needed for special uses such as high-grade veneer and that brings the highest prices. The benefits in increased timber values that result from stand-improvement measures and control of insects and diseases may be realized fairly soon or be long-deferred, depending on the age or size of the timber when treated.

Reasonable estimates of future timber yields and values can be made for short periods, but it is difficult to forecast yields and even more difficult to predict the course of timber values over many decades.

Silvicultural and economic research is gradually developing a factual basis for estimating the future returns from forest planting and improvement operations. Research and experience have already brought great improvement in forest nursery practices and in the technics of forest planting and insect and disease control. The costs of such projects can, therefore, be estimated quite closely.

So far, programs for timber development and management have not been tied definitely to an appraisal of costs and benefits, although these have been taken into account in a general way. The job to be done is so much greater than the resources available for doing it that the policy has been to concentrate planting in regions where the need for it is most acute. Within these regions, the prospect of obtaining maximum results in terms of area successfully planted has been one factor in locating projects. In general, planting has been and should continue to be done on the sites that promise the largest returns in value of timber crops and the lowest costs of planting and subsequent protection and management. Exceptions to this rule will be areas where establishment of a forest cover is necessary for other reasons, such as protection of slopes or of watersheds. In such cases the gain through protection may be greater than any possible excess of costs over the returns from timber production.

The same general principle should apply in evaluating stand-improvement and damage-control projects.

Value as Source of Employment.—So far, a large part of forest planting, most of the stand-improvement work, and even a good share of the disease- and insect-control jobs have been carried on under emergency programs such as the CCC. Probably much of the same kinds of work in the future will also be carried on as work-relief projects. In such cases the expected return in timber values, while not entirely ignored, has less weight in deciding the desirability of a project. When part of the cost can be charged off against relief there is often justification for undertaking jobs that promise somewhat less financial return than would otherwise be expected. For work-relief programs, areas will be selected on the basis of such factors as accessibility to camps or other work centers, ease of doing the work with relatively untrained casual labor, and adequacy of area to provide enough employment to justify overhead costs. It should be axiomatic that a project would not be approved simply to make jobs; it should offer reasonable prospect of worth-while results in products and benefits.

Place in the Forestry Program.—Timber-management projects should contribute to the effectuation of the over-all forestry program, and should be coordinated closely with other classes of forestry projects. For example, there will be little advantage in acquiring large areas of denuded land or badly wrecked forest in areas where timber growing is a major need and opportunity, unless steps are taken fairly soon to rehabilitate it. Critical areas should be planted or given other necessary silvicultural treatment in connection with erosion-control or water-conservation programs. Many projects, well distributed throughout the country, should serve as object lessons to demonstrate methods and results to other forest owners. Species and kinds of products grown should be determined on the basis not only of the biological factors but also of the economic factors in each locality.

Timing of Projects.—Most timber-resource-development projects are closely interrelated and should follow a rather definite sequence on a given area. Thus, a young plantation usually requires weeding and cleaning to remove competing vegetation and favor growth of the best individuals. As it grows older it has to be thinned at suitable intervals if it is to produce high-grade timber. If clear timber is wanted, pruning of selected trees may be necessary at a certain point in the life of the stand. Improvement or sanitation cuttings may be required from time to time, to remove undesirable members of the stand or reduce loss from insects, disease, and storms. Once a stand has been established or improvement of an existing stand initiated, the succeeding steps should follow in due course. Most of them can be advanced or postponed, but seldom for more than five years, without seriously affecting timber yields. Timing of emergency insect-control and, to a less extent, of disease-control projects will be determined by the incidence of insect and disease outbreaks.

There may also be a best time for starting forest development on a given area. For example, a recent burn can sometimes be planted most successfully and at least cost before growth of competing vegetation or erosion of the topsoil makes planting difficult and costly. In some cases, planting of a freshly cut-over area should be deferred for a year or two to avoid losses from weevils or other pests. In other cases, the work should wait until fire hazard has been reduced

by appropriate control measures or through decay of the slash.

Particularly where an important objective is to provide employment, seasonal projects should if practicable be carried on in conjunction with other kinds of work that may be done at other seasons. In this way the workers will have longer employment and the forestry work can go ahead on a more even front.

Priorities.—Some of the points to be considered in determining priorities for forest-land-use projects in general are outlined in a preceding section of this report. Some of the criteria applying specifically to forest planting and management are the following:

1. Emergency situations should have high priority. Examples are critical watershed areas where delay in establishing forest cover will result in serious erosion, silting, and irregularity of run-off. Another example is an area of concentrated tree-disease infection or insect outbreak, which can be checked by early action but will get out of hand if not attacked promptly.

2. Areas of high potential productivity, producing valuable species, and readily accessible to nearby users deserve consideration ahead of areas with the opposite characteristics.

3. Projects that will return benefits fairly soon should be preferred, other things being equal, to those that will yield benefits only in the distant future.

4. In planting, areas that will not restock naturally within a long period, if at all, should be dealt with before those on which a fair natural restocking can be expected without too much delay. This is true only if other factors, such as productivity of site, local need for forest cover and timber products, and costs of planting, are approximately equal.

5. When jobs are needed mainly by rural people projects that will provide them employment should have high priority. First preference should be given to those projects that will enable the workers to live at or near their homes.

6. When the programs are expanded to relieve unemployment generally, so that large organized work camps will be set up, fairly large-scale projects or projects that can be integrated with others to provide a large work load will be preferred to small or short-seasonal projects.

The Shelterbelt Project

Introduction

The Shelterbelt project is located in an expanse of prairie-plains about 1,000 miles long, which in North Dakota lies between the 98th and 100th meridians. From North Dakota this area runs south through eastern South Dakota, then it bends westward to central Nebraska, and thence through middle Kansas into the east of the Texas panhandle. In this area conditions prevent natural tree growth almost everywhere, but artificial planting will succeed if carefully done in the right places.

At the time the general outline of a Shelterbelt Project was developed, there was available considerable information to serve as a guide for the work. Millions of trees had been planted by farmers to beautify and protect their homes. An impetus was given by the Timber Culture Act which gave the settler 160 acres of land if he planted a certain proportion of it to trees. It is true that many of these plantings had died, but even the failures taught something, and this, added to the results of observations on surviving trees and groves indicated plainly that shelterbelts, if planted systematically under proper technical guidance, would thrive and bestow far-reaching economic benefits on the Plains.

The purpose of a shelterbelt is to protect the fields against drying winds and drifting of the soil. The main belts are 60 to 110 feet wide and comprise 5 to 10 rows—shrubs on the windward side, then short-growing trees, then tall-growing trees, and, lastly, on the leeward side a row or two of short, branchy trees. Such a belt is wind-resistant from the ground up. Intermediate belts may have only 2 or 3 rows.

The shelterbelts are engineered, so to speak, into the land. Two things are necessary: the belts must grow and, when grown, they must afford maximum protection. Making sure of both requires that due attention be given to factors like topography and wind, which govern effectiveness, and also to factors such as soil, which determine whether trees will grow or not. Because of this a good deal of planning is necessary. Shelterbelts cannot be located at random nor pursue fixed predetermined patterns and, of course, the notion that was promulgated by the press when the project was first proposed—"A hundred-mile-wide belt of trees"—was easily, perhaps inevitably, misconstrued.

It should not be supposed that shelterbelts will modify the general climate of the Great Plains. They will not do this, but they do modify the local climates by deflecting the wind, casting shade, catching and holding snow, and conserving soil moisture. In general, the effects of the plantings extend to leeward a distance about twenty times the height of the tallest trees.

Status of the Project

Work under the Shelterbelt Project, which has been carried on from the beginning with emergency funds, has been continuous since 1935. By 1940, 13,684 linear miles of shelterbelt had been planted on 22,130 farms.

Most attention is given to establishing the main shelterbelts, comparatively little to intermediate belts, and none whatever to windbreaks for houses, gardens,

feed-lots, and the like. The main belts have somewhat the same relation to intermediate belts and specialized windbreaks as Federal-aid highways bear to State and county highways and market roads.

Growth and survival of the shelterbelts have been better than anticipated. The benefits come up to expectations. Among these are the following:

1. Promotion of soil stability by reducing wind and water erosion.
2. Increase in crop production by preventing losses due to destructive windstorms.
3. Conservation of moisture through reduction of evaporation and transpiration, and by collection and protection of snow.
4. Protection for livestock and poultry, with marked increase of production per unit of feed.
5. Reduction in fuel required for heating buildings.
6. Production of fuel, posts, and rough lumber.
7. Provision of an improved environment for wildlife, especially insectivorous birds.
8. Facilities of diversified agriculture, at least to the extent that gardens, small fruit, and some orchards are made possible.
9. Protection of physical facilities—roads, buildings, fences, machinery—against rapid deterioration.
10. Improvement of the Plains as an environment in which to live.

Planting 165 million trees (1935–40) has demonstrated that this type of planting can be successful. The most formidable obstacles to shelterbelt establishment have been overcome. Such problems as selection of species, protection against insects, rodents and diseases, and adaptation of species to soils are fairly well in hand. Climatic obstacles have been overcome largely by careful selection of sites and species and by cultivation, so that the plantings have come safely through the most severe drought ever to afflict the Plains. Shelterbelts have turned out to be the best and the nearest to a permanent means of protecting crops and homes and reducing wind erosion that have been developed for the Plains.

Place of Public Works in Shelterbelt Planting

Shelterbelt planting provides a large reservoir—up to 1 or 1.2 million man-months—of highly constructive work in a part of the country where relief is a major problem. A large proportion of its cost goes to unskilled labor using simple tools, and since the bulk of the work can be done in slack seasons, intermittent employment can be provided for local farmers, agricultural laborers, and many who ordinarily work on construction. Shelterbelt planting can be expanded or contracted in two to four years, depending upon the age of the planting stock used and hence upon the time required to produce it.

Experience demonstrates that at least 30 percent of the money allocated should be made available in regular recurrent appropriations in order to maintain administrative and technical staffs and tree nurseries and to keep headway on the job of planning, education, and negotiation of cooperative agreements for planting and care of the shelterbelts. This 30 percent is the minimum required to provide a framework around which to organize efficient use of emergency funds.

The Program

Considering the area of plantable soils, the size of planting per farm, and the total number of farms, it is estimated that in all, 2½ to 3 million acres should be planted within the shelterbelt zone.

An adequate annual program will be large enough to make an annual impression on the general situation, yet not so large as to result in inefficient operation. Such a program will involve planting some 4,000 miles or 40,000 acres of shelterbelt per annum. The main factors that inhibit expansion beyond this point are the large labor requirements for the planting season and the large number of farms (7,000 a year) to be dealt with.

The following program, suggested for 25 years of shelterbelt planting, represents less than half of the work that is both practical and desirable.

TABLE 32.—*Conservative 25-year program of shelterbelt planting for the Great Plains*

State	Area	Total length	Farms involved	Employment.[1]
	1,000 acres	*Miles*	*1,000's*	*1,000 man-months*
North Dakota	175	17,500	25	75
South Dakota	200	20,000	35	75
Nebraska	215	21,500	35	85
Kansas	210	21,000	34	85
Oklahoma	125	12,500	21	50
Texas	75	7,500	10	30
Total	1,000	100,000	160	400

[1] Provided by the Federal Government only; the cooperators contribute the rest.

Financial Responsibility

It is impossible to compute in dollars and cents the extent of the public interest in establishing shelterbelts in the Great Plains, because the public benefits include several intangibles. The present 60–40 ratio of public to private contribution has provided sufficient incentive to landowners to undertake shelterbelt planting on a substantial scale. The progressive degeneration of the Prairie-Plains region has reached a point where the Nation must choose between taking

steps for improvement and seeing large areas go out of production. The latter eventuality would result in human suffering and misery and large-scale migration. Relief needs in the Prairie-Plains region have been among the most critical in the country, and the Government has spent 2½ billion dollars there. Shelterbelts will help to maintain productivity of the land and thereby to reduce costs of relief.

On their side, the farmers, plagued by the ills of agriculture, stricken by drought, and chronically short of cash, are unable to contribute much more than their own labor, a few materials such as fencing, and the use of farm machinery. They can care for the shelterbelts after they are planted and many of them can supplement the main belts by planting intermediate belts, farmstead protection belts, and woodlots.

Basis for Evaluation

With a 50–50 basis of Federal to private contribution, an acre of shelterbelt will cost the Federal Government about $40.[2] This acre will protect 20 acres of cropland; the belt will last 50 years or so, and can be handled so as to renew itself. On this basis the Federal cost may be expressed either as about 4 cents (no interest) or as a little less than 8 cents (including 3 percent interest) a year per acre of protected cropland. It is true that the public benefits of shelterbelts are largely intangible and do not lend themselves to precise appraisal, but it is true also that there is not enough information available to permit expressing the tangible benefits in precise terms either. It is known, however, that shelterbelts can make the difference between a successful farm and a failure; their benefit therefore is often far in excess of their costs.

Within the zone of the Shelterbelt Project, the priorities which should prevail, as between localities, can be determined through inventories of physical and economic factors. One thing to avoid is planting trees in places where the land to be protected will eventually be converted to a use that does not require shelterbelt protection; another is perpetuation of submarginal agriculture. Another problem is to strike a satisfactory balance between the need of protecting the most valuable lands and the desirability of providing assistance to the landowners who need it most urgently. Much of the information required to solve these and other local evaluation problems is available, but there should be continuous study and investigation with a view to improvement.

[2] Costs to the Federal Government have been $53 an acre and the Federal-private participation has been on a 60–40 basis. It is estimated that if the program were carried on regularly on the recommended scale, it would permit economies, including a change in the participation ratio to 50–50, which in turn would reduce the Government's share of the cost to $40.

Watershed Improvements

Nature and Scope

Watershed management is one phase of the broad field of forest land management. Its major objective is to realize not merely the maximum amount of water that can be delivered from a watershed, but rather the amount that can be delivered for continuous, well-planned use on the basis of soundly established priorities, without unnecessary waste and without damage to other resources.

The basic conception of watershed management lies in the control of the density and composition of the all-important vegetative mantle which springs from the soil. Vegetation is the only major natural element determining the course of water in its transition from rainfall to run-off, that practicably is within human power to control over large areas. The practice of forest watershed management, therefore, is founded on the treatment of forest cover. This treatment consists of measures that restore, protect, and modify the cover. They include cultural operations applied to trees and associated vegetation, as well as supplemental physical improvements on the ground.

Of the snow and rain falling upon a watershed, a part is returned directly to the atmosphere by evaporation. The usefulness to man of the remainder depends upon the manner in which it moves through and discharges from the watershed. Run-off that flows over the ground, quickly reaching watercourses and producing abrupt fluctuations of stream flow, is the primary cause of soil erosion and flash floods, and partially dissipates the potential usefulness of the precipitation. In contrast, water absorbed by the soil percolates through underground channels, is released gradually, and generally is more useful.

Probably the most important influence of the forest on waterflow is that exerted by the ground litter of leaves, branches, and other vegetable matter. Litter retards flow and holds back water for absorption. Litter also tends to delay soil freezing and lessens frost penetration, and thereby helps to shorten the periods during which freezing sharply reduces the water-absorbing capacity of the soil. Through decay and chemical change it forms humus, the organic matter that improves the water-holding capacity of soil. Rain falling on bare soil carries fine material into the minute spaces between soil particles and thus prevents further infiltration of water. But water reaching the humus is readily absorbed, and under suitable circumstances percolates through the interstices of the soil and the openings left by decaying roots and soil organisms. This replenishes underground storage, sustains base flows, and shortens the intervals of minimum stream flow.

Another way in which forest cover promotes the entrance of water into the soil is by reducing the impact of rain upon the forest floor through interference of the tree crowns and trunks. Furthermore, by shading the ground and reducing wind movement, forest cover retards snow melting and reduces the rate of evaporation from the soil. The pattern of forest canopy materially affects the amount of snow accumulation.

Streams from well-managed forests normally are clear and carry little sediment. Minimizing of soil erosion is an important watershed service of the forest. This aids in maintaining desirable water qualities, and in preventing flood damages from water-borne rock and soil and economic losses from sedimentation.

A major purpose of forest protection and improvement is to produce the watershed benefits that stem from well-managed forests. These benefits serve as an evaluation factor in determining work priorities in many management activities. Satisfactory protection and management of the timber resource can go far toward meeting the requirements of watershed management. Because of this, projects necessary or desirable in other phases of forest-land management include collectively the greater proportion of works of practical value for watershed-management purposes. To avoid duplication, measures of this kind that clearly are associated with other forest activities are discussed under those activities, even though they may yield concomitant watershed benefits.

Although watershed-management objectives can largely be met through other forest-land management activities, there is a certain volume of nonrecurrent work in aid of watershed improvement that cannot be reached in this manner. This work includes control of erosion and establishment of vegetative cover under circumstances where establishment of timber or forage crops is not a practicable method of watershed improvement. Examples are watersheds having vegetational types of little or no value as timber or forage; or areas so damaged by erosion that special watershed improvement work is necessary to establish a base upon which forest vegetation may become established. Other measures include stabilization of upstream channels and stream banks, to improve the regimen of streams. Revegetation and structural devices are used separately or together in carrying out watershed improvement projects.

Revegetation measures include the use of cuttings, planting, wattling, sodding, and seeding. Tree or brush species, shrubs, vines, grasses, grains, or weeds may be used. Mulches of field and forest litter are frequently employed and, where desirable, fertilizer and topsoil are utilized to assure success. Locally available plants and other materials are commonly used.

Physical improvements and minor engineering work are employed to supplement vegetation in the permanent control of watershed conditions. Devices such as terraces, contour trenches, water spreaders, diversion ditches, and check-dams are used to control erosion and encourage infiltration of water into the soil. These improvements form the temporary base from which vegetation can restore permanent watershed stability.

Structures commonly employed in channel stabilization are deflectors, retaining walls, channel barriers, and debris basins. Channel stabilization is of considerable importance locally in some mountainous sections. There, high values in valleys below steep erodible watersheds are protected by minimizing the shifting and scouring of channels that carry much sediment. Some of this work is quite simple. In its more difficult aspects, a high order of engineering ability is required to plan and design structures and efficiently integrate a channel-control system.

Variation in the Importance of Forests in Watershed Protection [3]

Bad conditions of stream flow and erosion exist somewhere in every major drainage basin of the United States. Over an enormous area much of the vegetative cover has been removed by fire, overgrazing, destructive logging, and other misuse. The result has been higher and more frequent floods, the washing of topsoil from millions of once fertile areas, deposits of silt in stream channels and reservoirs, accentuated water shortage during periods of low flow, and reduced productivity of the land.

The degree of forest influence on watershed protection depends on the type and condition of the forest, the character of the soil, the amount and distribution of precipitation, and the topography. The relative importance of the forest influence depends upon the intensity and purpose of use for the water and upon values liable to destruction by floods and silting.

The relative importance of forests in watershed protection may be indicated by classifying them into three groups; viz, those of major influence; those of moderate influence; and those of slight influence.

Forests of major influence (about 316 million acres) include those on steep slopes that are subject to heavy rainfall; on areas subject to high snowfall and rapid snow melting; and on areas that have unusually erodible soils, where in the absence of forest cover serious damage would be likely to occur. In localities where water is essential to the utilization of the agricultural

[3] A more detailed discussion of the subject matter included in this and the following section is contained in "A National Plan for American Forestry," the report of the Forest Service of the Department of Agriculture on the forest problems of the United States in response to Senate Resolution 175, Seventy-second Congress.

lands and where it is necessary to conserve as much of the run-off as possible, the forest cover has been classed as of major influence even though it is far from a complete canopy.

Forests of moderate influence (about 144 million acres) include those on moderate slopes, on areas of moderate or scant rainfall, on soils that do not erode readily, and where the vegetation quickly recovers following destruction by fire, logging, or other causes.

Forests of slight influence (about 170 million acres) include areas of more or less level topography, and forests on lava flows or deep sandy soils through which precipitation readily percolates, and from which erosion is slight. Also included are forests on poorly drained, nearly level areas.

Problem Areas Where Special Improvements Are Needed

Although watershed conditions differ greatly in the several regions, there are important problems that are common to a number of large drainage basins. Throughout the United States, in areas where forests are important for their watershed services, there is some need for works of watershed improvement besides measures for other forestry purposes. However, there are certain broadly defined areas within which the cover and the soils have been so affected by use and abuse of the land that special watershed-improvement measures are necessary. The principal regions where watershed improvements, alone or in combination with other forest improvements, are a significant part of a forest-land improvement program are the Piedmont and Upper Coastal Plain of the Southeast, the Mississippi River bluff and silt-loam uplands, and the semiarid woodlands and brush lands of the West.

Piedmont and Upper Coastal Plains.—Erosion and floods are the outstanding watershed problems in the Piedmont and Upper Coastal Plains sections of the Southeast. The forest cover, originally almost complete, now extends over only about two-thirds of the area. The land cleared for farming gives the most trouble. Improper methods of agriculture leave highly erodible soil exposed to abundant rainfall year after year. This has resulted in excessive sheet and gully erosion, diminished soil productivity, and widespread land abandonment. Improperly tilled lands and unhealed, abandoned farm lands are responsible for serious siltation of navigable channels and of reservoirs used for power development and domestic supplies. Land made worthless for cultivation or pasture must be returned to forest cover in order to reclaim its watershed services. Given protection from fire, natural vegetation largely will accomplish this. But there are many places where erosion has left only infertile subsoils or where large gullies are marching unchecked through forests. In such places, terraces, check-dams, intercepting ditches, establishment of erosion-resistant vines, and other special devices will be necessary to halt land destruction and to furnish the base from which permanent forests may become established.

Mississippi River Bluff and Silt-loam Uplands.—The bluff lands of the Mississippi River and the lower reaches of its major tributaries form a narrow belt extending approximately from New Orleans to St. Paul. These steep, broken slopes and silt-loam uplands adjacent to the river terraces occupy about 20 million acres, of which two-thirds lies below the mouth of the Missouri River.

The forests, once almost continuous, have been reduced at least three-fourths by fire, grazing, lumbering, and clearing for agriculture. Erosion from these bluff lands probably contributes more sediment to the Mississippi River than any other area of comparable size. Highly erodible soils favor the formation of steep gullies which spread rapidly and are not easy to check.

Erosion is largely the result of the cropping of land that never should have been cleared, and the use of wrong cropping methods. On much of the land, cropping has become impossible and it has been abandoned. Erosion and silting can be checked only by adopting proper methods of management for both farm and forest lands. This will mean transfer from farm crops to forests of land that is submarginal for cultivation, adequate fire protection on all timberlands, and reforestation of the land on which erosion otherwise will continue. In areas where erosion is most severe, reforestation will have to be preceded by the installation of mechanical erosion checks and the planting of especially erosion-resistant plants.

Semiarid Woodlands and Brush Lands.—Throughout the West there is a belt, usually below but sometimes intermingled with commercial timber, where, because of semiarid climate or past treatment, the cover consists of scrubby timber or brush. Chaparral, piñon-juniper, aspen, and oak brush are the predominant cover types. The natural balance is finely drawn. Even slight changes in cover may give rise to an adverse watershed condition not easily overcome. Almost all of this area except the dense brush fields of the southern coastal drainages of California is used as livestock range.

The major watershed problem is erosion. Locally, floods and mud and debris flows are of great importance. Most of these areas are the lower parts of watersheds that head in the higher timber belt, the water-producing area that supports the economic life of the West. Under such circumstances these areas feed eroded material into the stream channels from the upper reaches of which water is obtained for irri-

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gation, power, and domestic use. Less frequently, as in southern California and parts of the Southwest, the woodland areas themselves are the main source of water.

In southern California, protection from fire, a difficult, highly specialized job, is by far the most important single activity in aid of watershed improvement. Elsewhere, fire control is less important as a practical problem because it is not particularly difficult, and regulation of range use so as to maintain the cover is the prime necessity for the protection of watershed services.

In southern California, watershed values transcend all others, and in certain other sections, notably along the Wasatch front, these values exceed or equal any others. Within such areas destruction of cover followed by sheet and gully erosion and channel and stream-bank cutting, has made necessary large expenditures for watershed improvements to protect downstream values. On the slopes revegetation and mechanical devices to retard waterflow are necessary; and in the channels, check dams, debris barriers, retaining walls, and other engineering measures are required to stabilize channel courses and stream debris in transit.

Public-Works Projects for Watershed Improvement

Accurate data are not available from which to estimate the amount of watershed-improvement work that should be done on forest lands in order to solve those problems that are not reached by programs for forest-resource development. Fragmentary information gathered for various land-condition surveys provides some local data. To obtain reasonably complete information, surveys of problem areas are needed. Such surveys should be coordinated with other land-condition surveys.

Much experience has been gained in the past decade in developing and applying methods of starting severely damaged watersheds on the way toward reclaimed usefulness. From what is known of the extent and severity of damage to forests and forest lands, it is estimated that at least 320,000 man-months of work could be expended now on special watershed improvement projects. Since areas sufficiently damaged to require special treatment usually become progressively worse if not controlled, and since the costs of rehabilitation increase proportionately, delays in starting projects will add to the over-all costs of the program.

In general, the work proposed would be widely distributed across the United States, but would tend to be concentrated largely in certain areas previously mentioned. In southern California, where there is a large volume of work to be done, projects are within daily commuting distance of large urban and suburban populations. In the Southeast, where another large segment of work is necessary, projects are close to a large, economically depressed, rural population. In other areas the work is accessible to small populations of forest communities.

The projects are of a type for which work technics are being developed rapidly by public agencies concerned with land-improvement programs. Projects are being carried on currently on a limited scale, and leadership is available for program expansion.

The projects should be planned and executed on a watershed basis which provides considerable flexibility, for small watersheds, as well as large drainage areas, can be planned as units. This flexibility permits ready adjustment of work to the rapid expansion or contraction of a public-works program.

In general, labor expense would approximate two-thirds of the cost of the project. On some projects the materials employed, such as vines, shrubs, rock, and brush, involve little expense other than the labor of collection. Little use of machinery is required. Nearly all types of construction work are suitable for hand labor.

Timing of work presents few rigid restrictions but where practicable should be adjusted to other forest activities so as to achieve a coordinated forest-land-improvement program. Preparation of the ground for revegetation and building of structures can be carried out during all outdoor working seasons. Planting, however, can be done during only a few months in the year, usually in spring and fall.

Financial Responsibility

The costs of rehabilitating denuded and eroded land and stabilizing stream channels are essentially nonrecurrent. In each type of work, the aim should be to bring about conditions of protection that can be maintained by natural growth processes. After the work program is completed, nature must take over the responsibility of maintaining the improvement. Substantial expenditures for replacement and maintenance should be required only in cases of large-scale failure of revegetation programs, as a result of abnormal climatic variations.

Division of the costs among the beneficiaries will prove impractical in many cases. For example, a project of land rehabilitation by grading, check-dam building, planting of trees and soil-binding vines, will benefit the owners of the land by restoring its fertility and by preventing further spread of the damage. The landowners downstream will eventually be relieved of a portion of the damage they have been suffering from inundation and sedimentation of bottom lands. The useful life of storage reservoirs down the river will be prolonged and the productive value of the power or

irrigation project which they serve will be augmented. Costs of treating river water for domestic use in cities along the lower reaches of the river will be lowered, and the expense of maintaining navigation channels lessened. When the ultimate effect of the rehabilitation program is realized, the stream may become sufficiently clear to support abundant fish life. With the clarification of the water will come increase in the value of land along the river. Greater uniformity of streamflow throughout the year will be of general benefit to many interests, social and economic, private and public.

Rehabilitation of watershed values of publicly owned land gains for the public the direct benefits that accrue to the landowner and indirect and intangible benefits that are realized regardless of land ownership. Public ownership of forest land is primarily an expression of the desire of the people permanently to assure for themselves the benefits that forest lands can produce. For this reason, many measures necessary to reclaim the damaged values of public watersheds are not only a justified public expense, but matters of first-order priority in public forest-land management.

Federal participation in financing watershed-improvement work upon non-Federal lands should be predicated not only upon the basis of expected public benefits, but also upon assurance that these benefits will be safeguarded in the future by adequate land protection and properly regulated use. For lands under the administration of State and local governments such assurance should be readily obtainable, for it is unlikely that a public agency would invest its own funds to improve its watershed without taking steps to maintain the resulting benefits.

As for private land, satisfactory assurance requires the backing of public authority. Forest land so deteriorated that special measures are necessary to rebuild its watershed values offers but little incentive to the private owner to undertake work that will yield him few immediate benefits. It is scarcely to be expected that a landowner will expend more money for rehabilitation than the present or potential cash income from the land justifies.

The worst of such land must be placed in public ownership before rehabilitation measures can be undertaken with any assurance of permanent success. On some private forest land, particularly that associated with farms, the Federal Government can help private owners with land-conservation programs through cooperation with soil conservation districts. On most large commercial holdings, assurance that public interests in cooperative watershed rehabilitation projects would be safeguarded would require agreements with owners, or other more suitable procedures yet to be worked out.

Evaluation Principles

It has been pointed out that watershed management, development, improvement, and rehabilitation can be promoted through development, protection, and management of the timber and forage resources of forest land. It follows, therefore, that the effect of public works in these fields on watershed values should be a major criterion in the approval and selection of such projects. Watershed-management considerations should bear particular weight in evaluating projects in forest planting, public acquisition, and forest protection.

In rating the worthwhileness of projects proposed primarily for watershed rehabilitation and development, the following principles should be applied:

1. Expedite projects that are elements in unified land-use-adjustment programs.
2. Expedite completion of meritorious projects already under way.
3. Favor projects that aid in rehabilitating and stabilizing economic problem areas.
4. Approve structural treatments only when they will be accompanied by adequate restoration of cover or assurances of adequate land-use management. For example, stabilization of torrent channels should be accompanied by protection or conservational use of vegetation above.
5. Favor projects based on detailed surveys for water-flow retardation and soil-erosion prevention in the interest of flood control.
6. Prefer projects with valuable benefits known to exceed costs, but recognize that the limitations imposed by monetary evaluations are not strictly in accord with the principle of greatest good to the greatest number in the long run, for such evaluations may not include important nonvendible benefits.
7. Give priority to projects on public lands reserved or acquired for watershed rehabilitation or protection.
8. Approve projects for rehabilitation of non-Federal land only if adequate assurances are given that the improvements will be maintained.
9. Give priority among projects involving land retirement and population displacement, to those for which rehabilitation of the displaced people has been provided.

Aerial Forest Surveys

Need for Facilities

Knowledge of the location, extent, and economic value of forest resources is essential for the efficient management of forest land. An inventory having been made to acquire this information, it is possible to prepare a plan covering the uses for which the land is

best adapted, the cost of development, the resulting benefit-cost ratio, and the use of each resource. A resource plan is requisite for the orderly, systematic, and efficient protection and development of all resources. Maps of adequate scale and accuracy are essential for recording the data upon which the plans are formulated.

Until a few years ago these maps were prepared by ground methods. During recent years the superiority of aerial photography and photogrammetric methods has been thoroughly demonstrated. The cost of their use is small in comparison with the results obtained, and the amount and accuracy of detail are greatly increased.

The value of aerial photography is not limited to map making. The photographs are of great value in the resource inventory and in preparation of the resource plan. Through their use the development, protection, and utilization plans for each resource can be made in greater detail, with more accuracy and speed, and at less cost than by ground methods.

Forest Management.—Administration, particularly of large units, is facilitated by aerial pictures and the maps prepared from them, which permit determination of the exact location of existing transportation facilities and of resources such as timber, water, and forage. Such pictures and maps are useful in planning additional transportation facilities and in getting additional data on resources.

Protection, to be effective, requires thorough knowledge of topography, ground cover, and other conditions with which fire crews will be faced. The general location of a fire having been determined, photographs of the area, used in conjunction with the maps made therefrom, permit the fire dispatcher to study conditions as though he were directly above the fire. This permits efficient utilization of available fire-fighting facilities and greatly increases the speed and effectiveness of the suppression organization.

In Resource Utilization.—Timber is readily recognizable on aerial prints. Even density and relative height of the stand are apparent. In many instances forest types and even species can be determined. Location on the ground may be plotted. This knowledge is essential for timber-management plans.

Range-survey crews utilize aerial photographs as bases on which to indicate forage types and other information essential for preparation of management plans. The results, obtained at an appreciable reduction in costs compared with methods formerly used, are so superior in accuracy and detail that rarely is a range survey now undertaken without first taking pictures. Transfer of the recorded data to the maps that show related features is essential to efficient range-management plans.

Geologists in search of strategic minerals have come to rely not only upon maps but upon pictures from which they are made. Large deposits of strategic minerals are believed to exist on forest lands for which photographs are still lacking.

Flood-control surveys, completed or planned, include aerial pictures as one of the essentials for study of control measures on watershed areas.

The advantages of aerial pictures are not limited to the activities mentioned. Increased efficiency, reduced cost, more complete information, and adequate planning are sought in all phases of forest management. These may be obtained through the use of photographs in recreation planning, wildlife management, land acquisition and exchange, public-utilities planning, location of public-survey corners, and many other kinds of work.

Kinds of Facilities

Aerial Photographs.—Aerial photographs, to be of greatest use for land-use studies and mapping, should be taken with a single-lens camera. The lens may have a comparatively long focal length and cover a narrow field of view, or a short focal length and wider field, so that it covers a larger ground area for each exposure. The short-focal-length, wide-angle-lens picture has many technical advantages for mapping, particularly by stereoscopic plotting instruments. The narrow-angle, long-focal-length lens is superior for combined land-use studies and general map work. Equipment of this type is more plentiful than that of the other type, costs less, and provides pictures at low costs which afford clarity of detail, greater uniformity of scale, and less displacement. These are all necessary for land-use studies and, though not preferred, can be used for map production by stereoscopic plotting instruments.

Maps.—The planimetric map, which shows the relation of features in horizontal position, best meets the need of forest administration, protection, and utilization. Special data relative to land and resource use can easily be added by transfer from the picture on which they have been shown. In some instances, maps showing relief by contours are essential. Where needed, contours can be added to the planimetric map.

Relation to Public Works

The success and economy of any public-works program on forest land, being dependent on accurate knowledge of the resources involved, can be measurably advanced through aerial photographs and maps. Some public-works programs, initiated without adequate knowledge, have been improved materially because aerial photographs were obtained as expeditiously as possible to provide means of getting essential data.

Increased efficiency and savings in cost of obtaining data have been apparent almost immediately after the pictures became available. The taking of aerial pictures and preparation of maps from them are as essential to land-use projects as engineering surveys and preparation of blueprints are to any other works project.

Present Status and Future Program

Approximately two-thirds of the area of the country has been photographed from the air in the past 8 years. This includes most of the agricultural land, together with forest and other lands intermingled with and in the neighborhood of agricultural areas, as well as some of the national forests. Photographs are now available for probably 60 percent of the forest land. Some of these, however, are not of the type that is needed. Others are inadequate, because they were taken prior to recent improvements in photographic and photogrammetric methods. Greatly increased utility will be obtained if some of the previous work is repeated. Satisfactory coverage probably does not exceed 50 percent or 315 million acres of forest land. Maps of adequate scale, accuracy, and detail are available for a still smaller percentage of the forest land.

The work already done constitutes a basis for resource planning on the areas that have been covered. The remaining 315 million acres should be photographed and some 60 million acres rephotographed as soon as possible so that plans for development and management for the entire forest area may be prepared. The comparatively small areas of intervening nonforest land should be covered at the same time. Such photography during the last 14 years has cost the Department of Agriculture approximately $3.20 a square mile or 0.5 cent an acre. This is practically the same as the cost for 1938. In 1939 the average cost was reduced to $2.20 a square mile, and in 1940 to $1.95, as a result of the large volume of work and a balanced yearly program. Although indications are that the cost cannot be kept so low in the future, the benefit-cost ratio is so high that slightly greater costs are amply warranted. With proper planning and execution the program could be completed in 3 years.

From these photographs maps should be made available as needed for recording resource data. The time required will vary widely. Type of terrain influences costs of mapping in that it determines the type of ground control to be used and the methods to be employed. The cost of preparation of planimetric or "flat" maps to the scale and accuracy required for forestry activities ranges from 0.75 cent to 1.25 cents an acre, exclusive of photography. Greater accuracy or the addition of contours to the planimetric map will increase the costs materially, but they vary so widely that no estimate can be given. Addition of contours for forestry activities should be considered as a special project rather than the regular mapping job. It would require 3 to 5 years to complete this mapping program.

Rephotography and revision of maps will be necessary only when sufficient changes occur to make existing photographs and maps obsolete. The cost per square mile, with rare exceptions, should not exceed two-thirds of the cost of original photography and mapping.

Financial Responsibility

The benefits of such a program as suggested will be in proportion to the areas and activities of the several classes of owners. The nature of the work is such, however, that individuals or private organizations cannot generally be expected to do it or to pay for it directly. The Federal Government has financed most of the work that has been done, with some assistance from the States, and should continue to do so. Individuals and organizations making use of photographs should be required to pay the costs of reproducing them.

Basis for Evaluation

Technical Soundness.—Experience has resulted in the development of reliable methods and a high degree of technical efficiency both in aerial photography and in the preparation of maps from the photographs. It is safe to assume that any project of this nature proposed by a responsible agency will be sound as far as technic is concerned.

Relation of Benefits to Costs.—Photographs and maps are indispensable tools in forest-land-use planning. Maps derived from aerial photographs are more accurate than most maps made by other methods, and generally can be made more expeditiously and at less cost. For making any except the crudest maps or plans for use of forest land there can be no question but that aerial photography is justified from the standpoint of relative benefits and costs. The scale adopted and the detail shown naturally should be determined in accordance with the purpose for which the maps are to be used. In general, plans for intensive use of the land, especially where multiple or possibly conflicting uses are involved, would call for more detailed maps than where only extensive use is contemplated. As noted above, contour mapping, which adds to the cost, may be required in connection with certain forestry activities but may not be necessary for others.

Selection of Projects.—Essentially, photographing and mapping of the forest and other land of the United States is a single project, which should be completed

as soon as practicable. Other things being equal, it probably would be desirable to cover the country systematically instead of skipping around in numerous disconnected areas. But if for any reason the whole job cannot be completed within a few years, it will be necessary to assign priorities with respect to areas to be covered first. Such priorities should be governed largely by the relative needs for comprehensive plans for protection and use of the resources, and by the availability or lack of adequate maps and resource data for making these plans. For example, special needs may arise that will require certain areas to be mapped earlier than programmed. Examples would be areas like that covered by the New England blow-down of 1938, or areas on which an intensive program of flood or erosion control or fire prevention is to be started in the near future.

Wherever practicable, photographing and mapping of forest lands should be integrated with similar surveys of range lands, farm lands, and other rural lands, so that they may serve as the basis for coordinated planning for rural development.

Timing.—In planning programs of aerial photography, it will sometimes be desirable to make allowance for seasonal changes in appearance of the forest cover and general features of the landscape. For example, where deciduous trees predominate, it is better that all photographs within a given forest unit be made in the same season, so that there will be reasonable uniformity in the appearance of the forest cover.

Seasonal climatic factors, such as prevalence of fogs, rainy days, and smoke, which may limit the possible flying time, also have an influence on the cost of aerial photography and need to be taken into account in location and timing of the work.

Forestry Works Projects for Alaska

Introduction

Alaska is a national possession. The people of the United States own more than 99 percent of its land area and most of its natural resources. Many of these resources have been made available for development or use only under specially prescribed laws and rules which are intended to conserve the resource, to make the scheme of development compatible with the broad public interest, and to bring some financial return to the public owners. This close Federal supervision now covers the national forests, national parks, fisheries, water powers, coal, oil deposits, game herds, and grazing lands of Alaska. Agricultural lands of the open public domain and mineral deposits (other than coal and oil) are about the only important natural resources that are still available for patenting and use under the general systems that characterized the settlement of the Western States half a century ago.

Alaska is still an "empty country." Only 72,500 residents, white and native, were recorded in the 1940 census for its 586,400 square miles, an area larger than that portion of the United States east of the Mississippi River and north of North Carolina and Tennessee. A large portion of these people were concentrated in towns and villages on the southern coast. The past 2 years, however, have seen the start of large national defense measures, the establishment of scheduled commercial air transport connections with the Pacific Northwest, and an increasing interest in proposals to provide Alaska with both an internal arterial highway system and a highway link through Canada to continental United States. These features, together with the bad economic conditions of recent years over large sections of the more arid Western States, are stimulating migration to Alaska. This may prove to be the start of a long period of substantial gain in Territorial population. If the settlement of Alaska is to be kept free of the mistakes that were made in the early years of the West, the best possible on-the-ground management of the publicly owned resources should be provided before abuses or wrong practices have obtained a firm foothold. A long-term, well-planned system of public works on which construction can be applied from time to time as funds are made available will help greatly to further the proper protection, administration, and utilization of these resources.

The forests especially will benefit from such public works. Increasing demands on the commercial timber stands in the vicinity of the towns of interior Alaska, the importance of even the open woodlands in pioneer settlement, the relation of the forests to game and fur bearers, the high fire hazard over much of the timbered area, and the immensity of the forest region necessitate the extension of roads and other improvements at a faster rate than is likely to be possible with allotments from current departmental appropriations.

The Forests of Alaska

The forests of Alaska consist of two distinct classes, the coast forest and the interior forest.

The coast forest occurs on the south coast of the mainland and its numerous adjacent islands as far north and west as Cook Inlet. It is an extension of the dense conifer forest of the coastal sections of British Columbia, Washington, and Oregon. In Alaska it consists principally of western hemlock and Sitka spruce. The timber cover is confined to a narrow strip along the shore lines of the mainland and islands, rarely extending inland more than four or five miles

or above an altitude of 2,500 feet. The gross forested area is around 6 million acres, of which approximately 4 millions acres has timber of merchantable size and quality. This merchantable area is estimated to contain 86 billion board feet of timber. The merchantable stands average around 20 thousand board feet of timber to the acre but frequently have 60 thousand feet.

Owing to the humid climate, the coast forest has suffered little from fire. The best-timbered sections are largely included in the Tongass National Forest of southeastern Alaska and the Chugach National Forest of the Prince William Sound area. These forests are administered by the Forest Service, United States Department of Agriculture.

The interior forest comprises the prevailing type north of the coastal mountains, throughout the whole of central Alaska. It is a part of the forest which, with only slight local variations in characteristics, extends across North America in the sub-Arctic zone.

The most common stand is a mixture of white spruce and Alaska white birch, with northern black cottonwood as a frequent associate. It occupies the better-drained soils of valley floors and benches, low rolling ground, and the lower slopes of the high ridges. Growth is very slow. White spruce reaches a larger size than birch but rarely exceeds 18 inches in diameter and 50 to 60 feet in height. The type most frequently occurs as open woodlands but it also forms stands with a full forest cover. The timber cover seldom is continuous over extensive areas, but is broken up into blocks by grass, brush, and swamp types that occupy fully as much ground as the forests on any given large watershed.

The zone in which the interior forest occurs extends from the Chugach Mountains on the south to the south slope of the Brooks Range on the north, and as far west as Norton Sound, the town of Bethel on the Kuskokwim River, and the base of the Alaska Peninsula. No satisfactory estimate of the actual forest area within this vast zone is available but a conservative guess places the extent of the areas which grade from open woodland to dense forests at between 100,000 and 125,000 square miles, or 64 to 80 million acres. The average stand per acre for all classes of timberlands is probably about 7 cords, giving an estimated total volume of between 448 million and 560 million cords. The best stands of timber occur in the drainages at the head of Cook Inlet and the Tanana Valley.

Interior Alaska also has extensive stands of aspen on the steep, dry slopes, and thickets of alder, willow, and cottonwood on the valley floors.

The Department of the Interior has jurisdiction over most of the land within the zone of the interior forest. The Mount McKinley National Park and the Katmai National Monument are in charge of the National Park Service of that Department, but the great bulk of the lands has the status of open public domain, and comes under the supervision of the General Land Office. Privately owned holdings in the interior, as elsewhere in Alaska, are less than 1 percent of the total land area.

The Economic Importance of the Forests

Certain other regions of the world that lie in the same latitude as Alaska, and have the same climate and much the same kinds of resources, support populations of considerable density, and afford a good standard of living. The Territory can reasonably be expected eventually to attain a like condition. The present principal industries, mining and fishing, which are largely seasonal, will be supplemented with other classes of development that encourage year-long residence.

The forests are certain to play a vital part in establishing and maintaining an enlarged permanent settlement. Expansion of the commercial timber industries will provide more year-long employment on the south coast and in fact should almost double the present population of that region when the volume of the timber cut approaches the growing capacity of the forests. The widespread forests of the interior will supply the local population with the great variety and abundance of cheap wood products that are a requisite to the development of the agriculture, grazing, and placer mining industries, which must form the basis of any extended settlement in that region.

In addition to their value in the local economy, the forests of both coastal and interior Alaska can contribute substantially to the construction and operation of national-defense establishments in the Territory. Making use of local sources of forest products will obviate the high costs, delays, and dangers incident to transporting timber supplies from distant points and reduce the pressure for shipping space on military supplies not obtainable locally.

The Coast Forest.—The present and prospective economy of the coastal forest region is dependent on salt-water fishing, lode mining, and lumbering. Home gardens produce abundantly, but there is now little general farming and no possibilities for an extensive future agricultural development. This is due to the steep topography, wet climate, and the difficulties involved in clearing the densely forested land. The present population is approximately 29,000, of which 7,000 are native Indians. The salmon and halibut fisheries constitute the chief support of the people, both white and native.

Mining, the second important pursuit, will probably expand somewhat, but being based on a depletable resource, it cannot be regarded as a permanent factor in the economy of the region. Fish and forests, both re-

newable resources, will doubtless provide the stable, long-time industries. Practically all timber products for local use are supplied by these forests and two modern sawmills, each with a capacity of 100 thousand board feet a day, send material to the more northerly part of the Territory and ship clear grades of lumber through the Puget Sound wholesale markets to continental United States and foreign countries. Sitka spruce timber suitable for airplane construction is now being sent to American and British airplane factories and the quantity can be substantially increased if defense and war needs require. The output of timber products for all uses does not now, however, average more than 35 million board feet a year, although the possible sustained output under adequate forestry practice is estimated at one billion board feet.

The timber resources of the coastal region of Alaska are practically intact. The prospective demand for timber products from within the Territory constitutes but a small fraction of the possible continued yearly output. The large remainder will be available for the use of the people of continental United States or elsewhere, as the need develops and economic considerations permit of meeting it from this source.

Substantial use of the coast-forest resources will likely come through the extension of the pulp and paper industry to the Territory. Taken as a whole, the species and quality of the timber are more suitable for pulp than for other forms of timber products, while the use of wood in the form of pulp products is increasing rapidly. The manufacture of newsprint in Alaska would appear to be especially desirable because local conditions are favorable and the United States now imports three-fourths of its requirements. Consumption in 1940 was 3,750,000 tons and imports about 2,775,000 tons. Studies indicate a possible sustained production in Alaska of one million tons per year. No pulp and paper plants are now operating in Alaska.

The Interior Forests.—The social and economic development of the greater part of interior Alaska, both present and potential, is largely predicated on mining, farming, stock raising, and use of the abundant wildlife. The extent to which these activities can be expanded depends in large measure on the protection and proper use of the forest and other vegetative cover resources. The population of this region in 1940 was about 21,000.

Mining.—Four-fifths of the $27,658,000 mining production of the Territory in 1940 originated in interior Alaska, where the local economy is now based almost entirely on placer gold mining. All of the prospectors and most of the numerous small producers in this region use substantial quantities of local spruce and birch wood, both for camp purposes and in connection with mining operations.

Agriculture.—Agricultural products in considerable variety can be raised in interior Alaska, but agricultural development must be geared to the demands of industry, national defense establishments, and general development within the region itself. There is general agreement among investigators that outside markets cannot be reached profitably because of the long distances involved and competitive conditions encountered in such markets. About 10,000 acres are now cultivated by some 380 farmers in interior Alaska.

The potential agricultural area has been estimated to be as much as 65,000 square miles. This oft-quoted figure is now considered too high but investigations have been too meager to arrive at a supportable figure. In any event the actual area is sufficiently large to make it an important factor in the future economy of the Territory. The principal agricultural localities cover portions of the main valleys of the Tanana, Kuskowim, and Yukon Rivers in the interior plateau region, and the Matanuska Valley and the west side of Kenai Peninsula in the vicinity of Cook Inlet.

The pioneer Alaska farmer must draw constantly and heavily on the local forests for fuel, building materials, fencing, and other uses. He also needs grass and browse cover as forage for domestic livestock.

Forage conditions as well as market demands, in the above-mentioned agricultural localities, favor dairying and cattle raising as a feature of general farming rather than large, specialized, stock-raising enterprises. However, the prospective cattle and sheep raisers of the future grazing localities will be as much concerned as the farmer with the maintenance of the vegetative cover.

Wildlife.—Interior Alaska is rich in wildlife resources and is recognized as an outstanding habitat for wilderness animals. The game contributes to the food supply and the fur bearers to the cash income of many isolated local inhabitants. Between 1925 and 1940 the shipment of furs, exclusive of fur seals, from the Territory as a whole amounted to $40,654,000. The wildlife is also highly important in the local economy as an attraction that brings naturalists, photographers, painters, tourists, and other visitors who pay for local services. Local economic benefits are not, however, the only reasons for maintaining a numerous wildlife population. The general public of the United States, as owner of Alaska's game, demands it because of the widespread interest in wilderness animals.

Game animals and nonaquatic fur bearers cannot exist without forest or other vegetative cover. This is true even of the carnivores, because of their dependence for a food supply on rabbits, rodents, and other small animals that feed on the vegetation.

The outing party, trapper, fur rancher, geologist, surveyor, and, in fact, everyone who is engaged in any

outdoor pursuit in this pioneer region, is also dependent in many ways on one or several items comprising the cover resources.

Commercial Wood Products.—Little of the interior timber will ever come into the general timber-products markets. Birch trees of the best quality may be removed from some of the more accessible areas, such as around the head of Cook Inlet, for shipment to Pacific Northwest furniture and novelty factories. In the distant future, some of the more accessible white spruce may be shipped south for pulp manufacture.

Fire Situation in Interior Alaska

An outstanding menace to wildlife, stock raising, agriculture, air transportation, and general resource development in interior Alaska is the depletion of the forest, brush, and grass cover by fire. Since these vegetative types are intermingled in the region and all have economic importance and are subject to devastation by fire, they must be grouped together in discussing fire losses and in providing measures for fire protection. The effects of fire far transcend in importance the combined results of all other agencies that work toward the depletion of the land resources. The scant precipitation, the high proportion of daylight hours, combined with warm weather in the summer months and a matlike ground cover of vegetation, result in a high fire hazard. Not uncommonly, fires rage for many weeks and extend over hundreds of square miles before being checked by natural barriers, such as rivers, or by the coming of the fall rains.

In one instance, a fire that started in the spring was still burning in September. A fire in the Illiamna Lake region at the base of the Alaska Peninsula, which was reported in June 1935 by airplane pilots as constituting a menace to air travel because of the smoke, had then been burning for 2 weeks and had run for 50 miles. In the same summer a fire in the Kvichak River section, burning for more than 2 months in brush, grass, tundra, and scrub timber, covered an area estimated at 1,000 square miles. Numerous fires, many of which have been burning for long periods, can be seen in the course of a trip during the summer months along any main route of travel.

The most accessible localities, such as those around settlements and along roads, trails, and navigable rivers, have suffered the greatest fire damage and exhibit extensive areas of continuous burn. Large tracts have been almost denuded as the result of repeated fires.

This devastation goes on year after year in almost every section of the Territory north of the Pacific coastal strip and has been a serious matter since 1900, at least. No satisfactory estimates can be made of the extent of the damage done, but it is safe to say that millions of acres have been fire-swept at least once, and much of this area two or more times in the past 35 years. As long ago as 1915 an interested observer estimated that fires had covered an average of 1 million acres a year in the preceding 20 years. The slow growth of much of the vegetation in this sub-Arctic region, especially of the principle tree species, means an exceedingly slow recovery of the burned-over areas.

Fires in Alaska are almost wholly man-caused, for few are started by lightning. They are due in large measure to a lack of appreciation of their damaging effects on the vegetative cover and hence on the enterprises which this cover helps to support. Hunters, prospectors, wood cutters, and travelers leave behind them live camp fires and mosquito smudges which frequently result in extensive burns. Fires used in land clearing for cabin sites, homesteads, and placer mining are often set with no thought of preventing their spread to the surrounding wild lands. The past few years, however, have witnessed a considerable change of sentiment. Factors in the growing demand for better fire control include an increasing realization of resource loss as the burned areas continue to increase, the objections of tourists to a smoke pall that obscures the scenery, and the interference of smoke with airplane travel. The last named is especially important as both military and commercial air transportation is widely used in Alaska.

The General Land Office was given an appropriation of $37,500 from Congress for the fiscal year 1940 to initiate systematic fire protection on the open public domain of Alaska. The following year the appropriation was reduced to $27,000. With a forest, brush, and grass area of around 156,000,000 acres needing protection, such meagre appropriations do not permit of making a highly effective attack on the situation. However, the nucleus of an organization has been established with an experienced executive in charge, and a small staff of inspectors and district wardens. The Civilian Conservation Corps has contributed the services of a few hundred local enrollees to detection and suppression work. In view of its small financial resources, the fire-control service has necessarily confined its activities to campaigns of education against fire among the residents of the more hazardous areas and to fire-control work around the larger community centers.

Most of the national-forest area is in the coast region of light fire risk. Only the Kenai Peninsula section of the Chugach National Forest, comprising about 1,300,000 acres, lies in the hazardous zone and this has been given fire protection by the Forest Service for many years.

Opportunities for Public Works

Alaska is largely composed of natural regions, subregions, and localities which, although almost wholly undeveloped or having a single going industry, contain latent resources that can be used to broaden the base of the local economy. It thus offers excellent opportunities for advanced integrated land-use planning. Such planning should serve to obviate the poverty that has usually characterized the first generation of pioneer settlement everywhere, and it should likewise preclude the community collapse that has so frequently followed hasty, uncontrolled, and wasteful development of the natural resources that furnished the local people with a livelihood.

This needed over-all development planning is now to receive joint attention from the several Federal agencies most directly interested in Alaska, through the Territorial Planning Council. The planning surveys to be made will necessarily require evaluation and comparison of the most important resources, to serve, among other purposes, as a basis for programming a needed system of related public-works projects. The forests will doubtless be highly ranked in the reports from these surveys, owing to their outstanding value for maintaining permanent population and a high standard of living. Denudation or depletion of the local timber supplies in any subregion of interior Alaska would seriously retard practically every line of endeavor. On the south coast, the heavy commercial forest is the only available resource known at this time that can support a largely increased permanent population. Many of the general or multiple-purpose public-works projects of high priority, such as main highways, that will be provided for in the over-all plans will be based in part on their importance for forest protection, management, and utilization.

While general and multiple-use public-works projects represent improvements of the highest importance to the forest activities, they are beyond the scope of the present report and have been omitted from the recommendations that follow. Only projects that will be used primarily or almost exclusively for activities connected with the forests and other intermingled types of vegetative cover are included.

The urgent forest public works to be recommended at this time fall into two classes: Transportation and general administration (including fire-control improvements).

General Administration.—An organization for adequate fire control will necessitate, throughout the forest regions of high fire risk, the establishment of several control headquarters for district wardens and stations for subordinate fire guards and patrolmen. Each of these headquarters and stations must include improvements that are essential to the carrying on of the work in each particular case. The essential improvements are dwellings, garages, warehouses, tool houses, crew houses, gas and oil sheds, boat sheds, airplane hangars, telephone lines, and water systems. The telephone lines needed are relatively short lines and would extend out from the headquarters and stations along near-by travel routes that are subject to exceptionally heavy fire risk.

The field administrative work on the national forests of Alaska is largely carried on with seagoing motor launches. Additional shore stations at new community centers, industrial sites, and recreation areas are needed from time to time.

Airplanes are much used for internal transportation in Alaska. Distances are great and land and water facilities so meagre and slow that air transportation is often the cheapest method of travel, besides being much faster. One of the largest air transport companies of the United States furnishes frequent service among the larger centers of population in the Territory. Almost every town of 1,000 or more population has one or more local companies which offer plane charter service to any place where a landing can be made. Unprepared gravel bars along rivers, hard tidal flats, and the outwash plains of glaciers must now be used as occasional landing fields in the back country. Practically every town, regardless of size, has a landing field, but few of the fields at remote small settlements have more than one runway and most of these are dangerously short. The total number of air fields of all classes in the Territory is now 155.

All commercially operated airplanes in Alaska have two-way radio communication and cooperate with the public fire-control agencies in detecting and reporting fires, without cost to those agencies.

To make the back country of interior Alaska more accessible to fire-suppression crews, many more landing fields are needed. Each of these fields would need one runway with a minimum length of around 2,500 feet. This runway would be cleared to a width of 500 feet and be graded to a width of 150 feet. These landing fields will remove the hazard of landing on unprepared ground and also permit of speedily reaching other localities that now offer no natural sites for landing airplanes.

Transportation.—Alaska has only 2,485 miles of roads of all classes, an average of 22 linear feet to the square mile. A great additional mileage of roads must be built to meet the needs of the growing population. In addition, a number of truck trails are needed primarily for fire protection. These will be low-class spur roads, usually less than 5 miles long, and will lead out from

towns, mines, and community centers, and from points along the highways and navigable rivers. They are needed to improve the accessibility of lands that present an exceptionally heavy fire hazard. Some of them will serve the additional purpose of firebreaks around settlements.

Trails leading out from community centers and into the back country from points on the shores of the protected navigable waterways of the Tongass and Chugach Forests are needed to meet the expanding use of the recreational, mineral, and other resources of these lands.

The increasing use of timber and other forest resources from national-forest lands requires extension of the system of low-class forest roads. These will open up further sources of supply and will serve the nearby communities and the Forest Service in numerous ways.

Program

The proposed program of public works to cover the needs for general forest administration and transportation in Alaska is summed up in table 33.

TABLE 33.—*Public-works program for Alaska*

Proposed projects	Number or length	Total labor required
	Number or miles	*Man-months*
General administration:		
District headquarters	7	1,650
Fire guard and patrol stations	12	500
Shore stations for motor vessels (national forests)	6	200
Emergency air fields—fire control	100	11,400
Telephone lines	200	350
Transportation:		
Fire protection truck trails	400	1,550
Fire protection trails (national forests)	500	400
Utilization roads (national forests)	50	950
Total		17,000

PART IV—PUBLIC WORKS AND RECREATIONAL LAND[1]

1. GENERAL OBJECTIVES OF RECREATIONAL ACTIVITIES

In establishing priorities for land uses and in allocating land for various uses, recreational use must be recognized as an essential and it must be borne in mind that location and type are all important. To be fully effective, recreational opportunities must be within easy reach of the users with respect to both time and cost, and the land must be suitable for the recreational use which is planned for it.

Land is necessary for recreation and the recreational potentiality is a resource of the land. Recreational use is possible on most lands and on some lands it is the dominant use. Few would contest the fact that recreation in its broadest meaning is the dominant use of Yellowstone National Park. Similarly, although on a smaller scale, recreation is the dominant use on many other lands. The recreational use may be dominant because of the land resources itself, as in Yellowstone, or it may be dominant because of the location; as for example, an ordinary tract of forest land which happens to be the closest recreational area available to a large city.

When land is more important for recreation than for other uses, the recreational resource should be recognized and action taken to preserve it and make it available to the public.

The general objective of a recreational program is to provide all forms of recreational opportunities, including those provided through private enterprise, to meet the needs of the people. In accomplishing this objective the following actions appear to be important:

1. Recreational areas and facilities so located and of such type as to meet the day, week end, holiday, and vacation needs of all income groups should be provided.

2. Important and outstanding scenic areas, historic and prehistoric sites, objects and buildings, representatives of native plant and animal life, geological exhibits, scenic and historic parkways, ocean frontage and other areas that are of more value for recreation than any other use should be secured and preserved for public enjoyment and benefit.

3. Recreational use should be recognized in all land-use planning and full consideration of recreational resources should be given to lands managed primarily for other purposes.

4. The great importance of municipal recreational facilities and programs should be recognized.

5. The place of private enterprise in recreational development should be given full recognition.

6. Federal, State, and local recreational development and administration should be so coordinated that an orderly and efficient system of recreational areas and programs may be developed in which priorities, local and national, will be taken fully into account and administration will be by the level of government best able to meet the public needs.

[1] This statement was prepared by Conrad L. Wirth and Sidney S. Kennedy, of the National Park Service, and John Sieker, of the Forest Service.

2. THE NATION'S RECREATIONAL SITUATION

Present Status

The United States now has more and better facilities for recreation, and more use is being made of such facilities than at any time in our history. This situation has resulted largely from emergency and other expenditures in this field by all levels of government in the past 8 years.

We have available for recreation, over and above the requirements for agriculture, timber production, and urban development, 361,000,000 acres—19 percent of our lands. However, this acreage includes perhaps 67,000,000 acres of desert and bare rocky lands of little use for mass recreation, and most of it is located considerable distance from densely populated sections.

Such natural characteristics as undulating or rugged topography, water bodies, varied and attractive vegetation, and favorable climate affect the recreational usefulness of an area. The natural land and climatic characteristics in the Northeast, the upper portions of the Lake States, the Appalachians, the Pacific Northwest, the Rocky Mountain region, the Black Hills, and the California coast attract those who are able, during the summer, to seek recreation at a considerable distance. Again, the Great Lakes region, portions of the Northeast, the Cascades, the Sierras, and the Rockies invite distant travel for winter sports, while the dry sunny weather of the Southwest and the mild temperatures of the Gulf and South Atlantic coast draw many during the winter.

The National Recreational Survey

The necessity of formulating a coordinated recreational program was recognized by Congress in 1936 through the enactment of the Park, Parkway and Recreation Study Act (49 Stat. 1894), which directed the Secretary of the Interior, through the National Park Service, to make a study of the recreational programs and of the lands throughout the United States which are or may be chiefly valuable for recreation; and to cooperate with other Federal, State, and local agencies in the planning for coordinated and adequate public park, parkway, and recreational area facilities.

Pursuant to this mandate the National Park Service has cooperated with appropriate agencies in the Federal Government, the States, and the Territory of Hawaii in formulating State-wide recreation plans. The National Park Service has undertaken also, in cooperation with other agencies, special studies on park use and attendance, fees and charges, legislation, organized camping, hiking, and winter sports. Based to a large extent upon information made available through these studies the National Park Service has published a report entitled "A Study of the Park and Recreation Problem of the United States". This report sets forth the present situation and makes recommendations with respect to nonurban outdoor recreational areas and facilities and other phases of a well-considered program, such as administration, legislation, finance, and leadership; and both this and the State reports contain detailed listings of the various Federal, State, and local lands used in whole or in part for recreation. These reports should be considered as important supplements to the present statement.

Present Recreational Areas

While the National Park Service has been studying the entire national recreation problem, other Federal agencies charged with the administration of public lands have been giving recognition to the recreational resources on lands under their jurisdiction. Much of the information relating to these resources has been made available to the National Park Service for use in its recreation planning program. General statements concerning types of recreational areas and agencies administering them are given below:

1. The National Park Service administers the national park system which includes 163 areas containing 21,569,085 acres in continental United States, Alaska, and Hawaii. The system includes some of the outstanding scenic and scientific sites in the country, situated mostly in the public land States of the West; historic and prehistoric sites throughout the Nation; and recreational areas of regional and national appeal. Attendance in 1941 exceeded 21,000,000.[1] In addition, the Service administers 41 recreational-demonstration areas containing 327,907 acres.

2. The Forest Service, in response to insistent public demand for recreational facilities in the national forests, has prepared recreational plans for all of the national forests so as to effectuate an orderly development of recreational areas. These plans include provision for present and predictable future public needs. Recreational use has been coordinated with the other uses of the national forests so as to provide the greatest

[1] Travel year October 1, 1940, to September 30, 1941.

net public benefit. In making these recreational plans for the national forests, the Forest Service takes into account the recreational developments of other Federal and State agencies and has given attention to coordinating its recreational developments with those of other agencies.

There are 160 national forests in continental United States, the Territories, and island possessions, containing 175,843,405 acres. Primarily established for forest production and watershed control many of these areas also have secondary uses, including recreation, grazing, wildlife, and mining. Recreation is often a highly important use. Recreational users in 1940 totaled 16,163,000 plus an additional 22,000,000 who drove over the forest roads to enjoy the forest environment.

In general, except for fire-hazard restrictions, all national forests are available for recreation. Forest highways and roads are used extensively by persons desiring to enjoy the forest environment and to obtain the climatic relief which it affords. These roads, built primarily for administration and protection of the forests, pass through logging areas and cattle and sheep ranges, but the utilization of the timber and range resources is so managed that the recreational values along the roads are not destroyed, and many persons enjoy seeing evidences of how utilization of natural resources under good management is handled. Forest trails leading to high country and lookout towers are largely for protection and administration purposes, but have a secondary and very important value for recreation and are used for that purpose by thousands of persons.

On areas where public recreation is concentrated, the Forest Service dedicates small areas, generally 10 to 30 acres, exclusively to recreational use so as to protect the area and the public, and to increase the enjoyment of the recreationist by constructing simple facilities for his use. Five thousand such areas, totaling 100,000 acres, are devoted exclusively to recreational use. They are widely distributed and their management is an integral part of regular forest administration.

In addition, the Forest Service permits the development of recreational facilities such as resorts, organization camps, and summer homes by private individuals on Government land where such use does not interfere with public uses or the orderly administration of the forest.

3. The Soil Conservation Service adminsters about 7,315,000 acres, acquired under the submarginal farm land utilization program in 74 different areas. Although these lands were acquired primarily to effect adjustments in the use and occupancy pattern of submarginal farm areas, recreational facilities, largely for local use, have been developed on many areas through the PWA and WPA public works and relief work program. In 1940 about 1,300,000 persons visited these areas for recreational purposes.

4. The Fish and Wildlife Service has primary jurisdiction over approximately 7,250,000 acres of national wildlife refuges and in addition, secondary or dual control of 6,250,000 acres administered by other Federal agencies on which wildlife considerations are important. Although the number of visitors to refuges is relatively small, these areas play an important part in the conservation of resources that are of recreational value. This agency has developed a limited amount of recreational facilities on a number of its areas, largely for local use; and its policy is to continue such development in localities where the need exists and where recreation will not interfere with the primary objectives for which the refuges have been established. The conservation, protection, and propagation of wildlife is effective on all lands in providing an important recreational use.

5. The Bureau of Reclamation administers recreational facilities to a limited extent on its water storage projects. It also collaborates with other Federal and State agencies in planning, developing, and administering facilities for recreational use on the areas which it controls. The recreational use of these reclamation projects plays a very important part in the national recreation program as the projects provide water recreational facilities where they are greatly needed.

6. The Office of Indian Affairs provides recreational facilities for the use of Indians. Indian fairs, pageants, and festivals, and such recreational resources as historic and archaeologic features on the reservations are of interest to the general public. The public ceremonials of many tribes draw thousands of spectators.

7. There are many areas of the vacant unreserved public domain which are suitable for recreational use. Under authority of several acts of the Congress, the General Land Office sells or leases those lands applied for which have been investigated and determined to be chiefly valuable for recreation. The act of September 30, 1890 (26 Stat. 502) authorizes the sale of certain public domain for park purposes to incorporated cities and towns; the act of June 14, 1926 (44 Stat. 731) authorizes the sale or lease of unreserved, nonmineral public lands to States, counties, or municipalities for recreational purposes; the act of October 17, 1940 (54 Stat. 1192) authorizes the sale or lease of unreserved public lands for park or recreational purposes to any incorporated city or town in Alaska; the act of June 1, 1938 (52 Stat. 609) authorizes the sale or lease of tracts of the vacant, unreserved, public domain not exceeding five acres which may be classified as chiefly valuable for cabin, camp, or recreational sites. The act of Au-

gust 26, 1937 (50 Stat. 874) relating to the revested Oregon and California railroad lands, requires that the management practices employed shall include the provision of recreational facilities.

8. The States provide park and recreational areas for their citizens and visitors. Although these have not developed sufficiently to meet all needs, many outstanding areas have been preserved and developed for use. In 1939 there were over 1,500 State parks and related areas, containing more than 4,000,000 acres used by over 96,000,000 persons.

9. About 13,000,000 acres [2] in State forests frequently provide recreational opportunities as a byproduct of their primary use.

10. Municipal, metropolitan, and county recreation systems, containing some 650,000 acres, serve most of the people in the Nation's recreation program. Estimated 1938 attendance in these recreational areas was 600,000,000.

It is recognized that recreational facilities and programs within the corporate limits of municipalities are exceedingly important in a comprehensive public works program, as evidenced by hundreds of millions of dollars of WPA, NYA, and PWA funds that have been and are being expended in this field, and the tremendous need for additional facilities. The National Park Service is now cooperating with the American Recreation Association and the American Institute of Park Executives in conducting a Nation-wide survey of such facilities as of December 31, 1940. A similar survey was made in 1936, the results of which were published in "Municipal and County Parks in the United States 1935."

11. Private enterprise does and should play an essential part in the field of recreation. Recreation constitutes an important resource base and in certain sections of the country and in numerous communities is sometimes the primary source of income. Resorts, hotels, dude ranches, beaches, camps, picnic grounds, fairgrounds, various forms of entertainment facilities, summer homes, golf clubs, hunting and fishing clubs, skating areas, and swimming pools are illustrative of the many types of private facilities that provide recreational opportunities, particularly for those in the upper income brackets. Such private endeavor should be fostered and encouraged with proper safeguards for health and with more emphasis on coordination with public programs and on esthetic consideration.

Although adequate information is not available to treat the subject in detail, it appears that some form of coordination should be considered to insure good standards and to protect those in business. There is also the possibility that at least some of the private recreational fields might be expanded so as to relieve the public bodies of certain responsibilities. For instance, the use of public lands for summer home sites and the adoption of some method of subsidizing certain types of recreational facilities such as swimming pools and golf courses might be an effective way to provide recreational opportunities for the lower income group.

[2] U. S. Department of Agriculture Miscellaneous Publication No. 373. The figure includes certain alienated and tax-delinquent lands. Of the total amount, 2,397,000 acres in the Adirondack and Catskill Parks, which comprise the New York State Forest Preserve, have been included under item 8.

Recreational Requirements

The aggregate of individual needs comprise the needs of a Nation. In 1940 there were 132,000,000 people in the continental United States; population experts estimate that the country's population will be about 150,000,000 in 1960, and that it will be largely urban and nonfarm, as contrasted with its predominantly rural character during past years.

To enjoy the types of recreation offered on outlying natural areas, an individual must be able to travel. Studies reveal that approximately 42 percent of our population is, for all practical purposes, without means to travel; hence, such persons must spend their leisure periods close to their homes. Only about 10 percent of the people have ample means for extensive travel.

Attendance and use and preference studies of State park and related nonurban recreational areas reveal the following to be the most popular forms of outdoor activities: touring and sightseeing, picnicking, all forms of water sports, hunting, fishing, camping, hiking, climbing, horseback riding, a wide range of winter sports, nature study, and the study of history and archaeology. Among other forms of recreation which draw inspiration from natural features and settings may be mentioned music, drama, painting, and handicrafts.

In order to make the above activities possible, as well as those quieter forms of recreation there is need for an expanding program of conservation for outdoor recreation. Such a program should include the preservation of the country's outstanding recreational resources such as scenic, scientific, and historic areas wherever they are found, the reservation of wilderness areas and of adequate areas for wildlife, and the setting aside of numerous areas which possess recreational value readily accessible to population centers.

A beginning has been made in gathering data on recreational facilities and needs in the recreation studies made by the States in cooperation with the National Park Service and in other correlative studies. When these studies are completed they will represent

the nearest thing to a national recreational inventory and plan that can be visualized at this time. From data obtained through these studies more definite plans for a national recreation program can be made, the objective of which is to determine in detail the following:

1. Public recreational needs for the present and predictable future.
   - *a.* Kinds of areas and type of recreation to be furnished—local, State and Federal.
   - *b.* Location of areas.
   - *c.* Capacity to meet the normal week-end peak of demand.
2. Existing recreational facilities.
   - *a.* Kind, location, and capacity by ownership and type of recreation furnished.
3. Expansion possibilities.
   - *a.* Lands available and kinds of recreation for which they are suitable, by ownership.
   - *b.* Acquisition necessary—tracts of land needed to furnish the types of recreation in the localities where they are needed.
4. Coordinated 6-year recreational program.
   - *a.* Kind and location of new areas to be developed.
   - *b.* Kind and location of areas and facilities to be expanded.
   - *c.* Agencies best suited to develop and administer these areas.
   - *d.* Federal assistance.
5. Future plans and needs.
   - *a.* Probable future trends in recreation and future demands as leisure time and national income increase.
   - *b.* Probable fulfillment of 6-year program.
   - *c.* Probable future needs after 6-year program is completed.

A general plan for the provision of lands and the water required to meet the recreational needs of the American people and the responsibilities of the various agencies at all levels of Government in effectuating the plan is outlined in "A Study of the Park and Recreation Problem of the United States." This outline is quoted herein with some modifications which are desirable for the purpose of this particular paper.

Plan for Public Recreational Areas

1. All classes of population need areas and facilities for outdoor recreation. There is a particularly urgent need, however, for public recreational areas, of all obtainable types and providing for a wide range of beneficial activities, within easy reach of all urban people. Their daily living is among man-reared walls, man-built streets, objectionable noises and odors and for a large percentage of them, in poor housing. To provide what they need for frequent use requires—

a. Neighborhood playgrounds within easy walking distance (not more than a quarter of a mile) of all children.

b. Playfields and neighborhood centers within half a mile to a mile of all residents.

c. Parks, or other areas characterized by natural or man-made beauty, sufficient in extent so that wear and tear will not be such as to render the cost of maintenance of their attractive features prohibitive, and sufficient in number and so distributed that all citizens, no matter how poor, may enjoy them at least occasionally. The limit of distance for areas of this type probably should not exceed two miles.

d. Protection of urban and suburban streams and other waters from pollution and "uglifying" uses; provision of points of access and facilities for use in such places and of such extent as prospective use will justify.

e. Parkways along waterways and to connect major recreational areas.

2. For holiday and week-end use by city folks and by those who live in thickly populated or intensively cultivated rural sections, there is need of public recreational areas where picnicking, water sports, day and overnight camping, hiking, and other related activities may be enjoyed, and which are sufficiently large to provide those who use them a sense of freedom and a separation from crowds. As a general rule at least one such area should be within 25 miles of those for whom it is chiefly provided. A distance even less than that will assure increased availability to those for whom transportation is a difficult problem.

3. Because of the congestion under which city dwellers live, the pressure for adequate recreational facilities is exerted primarily in their behalf. Yet there can be no denying that the 43.8 percent of the population of the United States which the census of 1930 classed as rural have recreational needs which must be met, at least partly, by recreational areas publicly owned or freely usable by the public.

National and State parks, national forest recreational areas, and other related types of recreational areas are intended to attract and provide equally for all elements of the population. What the rural resident chiefly needs is something roughly equivalent to the parks and playgrounds established in and near the city for the urban dweller. Generally speaking, such areas as are acquired and developed for his needs will be smaller than the general run of State parks; they will include provision for many of the activities that characterize the city playground, such as baseball, softball, tennis, volley ball, badminton, horseshoes, and swimming. Of equal importance with these will be provision for group activities—picnics, musical and dramatic presentations, com-

petitive sports, festivals, pageants, and dancing—the means by which the dweller in the country may satisfy the gregarious instincts and the urge for self-expression which are given so little rein in the daily lives of millions of rural people.

4. For vacation use, by all the population, wherever resident, there are needed:

a. Extensive public holdings in all those parts of the country characterized by forests, rugged terrain, lakes and streams, or any combination of these characteristics. In the western half of the United States, where the Federal Government's policy of retaining its remaining forest properties was adopted in time to keep much of the most spectacular mountain area from passing into private hands, most of the land required for extensive vacation uses is already in public ownership, and the problem is largely one of adjustment of use and administration so that these lands may yield the largest possible return to society. In the eastern half of the United States, which contains 70 percent of the total population, the need is very much greater, while the means of supplying it through lands publicly owned is very much less.

Public ownership of lands, particularly by State and Federal agencies, has been rapidly extended throughout most of the regions east of the Rockies during the present decade. In the more rugged sections within this region, the United States Forest Service has now acquired 17 million acres of land. Some of it is suitable for vacation use, and much of this has been developed, or is under development for such use. Most of the lands acquired by the Forest Service, however are at such a distance from the larger cities that the mere cost of getting to them is so great as to make their use difficult or impossible for more than half of the people of the cities. Part of the rest can make fairly frequent, and the remainder at least annual, use of them, and their potential contribution to this kind of public enjoyment is considerable. Except for coastal frontage, it appears likely that in most of the States in the eastern half of the United States lands now owned by or included in the purchase program of the Federal Government, plus the holdings and proposed acquisitions of the various State conservation, park and forestry agencies, will come close to providing the lands needed for this type of use. On such properties, there is need for public campgrounds, cabin colonies, group camps, and the various kinds of public resorts, allocated as to kind, extent, and location in proportion to prospective public use. In this phase of the total effort to provide adequately for desirable public recreation, it is urgently necessary to coordinate planning among the several Federal agencies and the several State agencies, in order to provide what is needed and at the same time to avoid such multiplication of locations, or facilities, or both, and duplication of planning and administrative organizations as will lay a needless large administrative and maintenance cost upon either the user or the general public. For any region there should be a coordinated recreational plan in which all agencies and all lands shall have their proper place, as well as the individual plans prepared by each agency.

b. As indicated, most of the mountainous and other wilderness and semi-wilderness properties of the Federal and State agencies listed above are so located that more than half the population is unable to use them. The urban population of much of Texas, Iowa, Oklahoma, Nebraska, the Dakotas, and Illinois is located especially disadvantageously with respect to possible use of such publicly owned areas. Yet a vacation in the out-of-doors in attractive natural surroundings, where a reasonable variety of recreational occupation may be obtained is desirable for all and particularly for those whose limited means normally provide only limited recreational opportunities. And while they are desirable, neither rugged terrain nor spectacular scenery is essential to the enjoyment of an outdoor vacation experience. It appears, therefore, that the most pressing problem, if this desirable and beneficial experience is to be brought within reasonably easy reach of the whole population, is to provide vacation areas close to the persons who need them and who cannot afford to seek them at a distance.

Areas of the kind needed are pretty well typified by many of the recreational demonstration areas which were developed from submarginal lands acquired through a Federal purchase program in 1935, and which are now administered by the National Park Service. These possess, generally, an interesting and occasionally exciting terrain, fair forest cover that will steadily improve under proper protection and management, and flowing waters valuable for a variety of recreational uses. They are located, as a rule, sufficiently close to urban populations so that they may be used for short or long periods by persons for whom a trip as much as 200 miles from home represents a heavy financial outlay; they are close enough, too, so that subsidy of transportation for under-priviledged individuals or groups, if provided, will represent a comparatively small expense for each individual served.

It is in areas such as these, close to using populations, that provision should be made for organized group camping, as well as for such other vacation facilities as inexpensive cabins and tent camp sites, supplemented by development of these recreational facilities and services which are needed to make a vacation an interesting, enjoyable, and beneficial experience. Lands suitable for such developments are available in practically every State.

It will doubtless be found possible frequently to provide on a single area not only for vacation use but also for day, week-end, and holiday use.

5. Due to the extraordinary recreational value of ocean, lake and river frontage, both because of the opportunities it offers for a variety of physical activities and because of the "refreshment of mind and spirit" provided by combinations of land and water, the necessity of providing an adequate quantity and quality of such properties for public use cannot be over-emphasized. Adequate quantity may be defined as sufficient in extent to permit all necessary development without undesirable crowding or encroachment by private enterprise. Since the wildlife associated with water margins is often of exceptional interest to the public, ample area in which to permit its protection and display will add greatly to the public value of any such holdings. Frequently beach areas are associated with a hinterland of marsh and swamp which, while of low monetary value, provides the favorite habitat to a large and interesting variety of bird and animal life. Whenever possible such hinterlands should be acquired with the frontage and full protection accorded them.

It has been suggested that acquisition of at least 10 percent of the shore line of the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and of major lakes and streams would be justified by the public benefits that would result therefrom. This percentage applied to ocean and gulf frontage would provide approximately a mile of frontage for each 120,000 persons resident within 100 miles of salt water. Distribution of areas, of course, should be related as directly as possible to the distribution of this tributary population, though experience has shown that ocean beaches attract heavy patronage from much greater distances than 100 miles.

6. Those areas containing scenery of such distinction as does, or is certain to, attract users from considerable distances and in fair numbers, should be in public possession. "They should be characterized by scenic and recreational resources of kinds that are unlikely to be reasonably well conserved and made available for public enjoyment under private ownership, or which under private ownership are likely to be so far monopolized as to make it seriously difficult for the ordinary citizen to secure enjoyment of them, except at a cost in time and money disproportionate to the cost of providing that enjoyment."[3]

The inspirational values of exceptionally striking and beautiful scenery are great, even though difficult or impossible to calculate fully. For that reason selection of areas that contain such scenery is justified, even though prospective attendance might, in some cases, be comparatively light.

7. On the same plane with the scenic area but not as widely appreciated are areas or structures of historic, prehistoric, or scientific significance. There is need for continued and energetic effort on the part of public agencies to assure preservation of America's heritage of historic and archaeologic sites and structures for the enlightenment and inspiration of her people. As is recognized by the Historic Sites Act of 1935, such action does not necessarily involve immediate or even eventual public ownership, but may be accomplished in many cases without disturbing private or semipublic owners.

8. For special recreational uses, five additional types of development suggest themselves as important in rounding out and completing our State and Federal recreational systems. These are:

a. Parkways.—The modern parkway idea was represented earliest by county and other undertakings of the character of the Westchester County Parkway system in New York and the Mount Vernon Memorial Highway from Washington to Mount Vernon. Valuable precedents in the extension of the concept were established in New York State by the construction of the Long Island State Parkways and the Eastern State Parkway which is now under construction, leading from New York City to Albany. The Blue Ridge Parkway, extending from Shenandoah National Park to the Great Smoky Mountains National Park, now approaching completion; the Natchez Trace Parkway, following the course of a historic travel route, and now under construction; and the suggested Mississippi River Parkway—all these represent still further extensions of the original concept. They point the way to the utilization of the parkway on a national scale to supplement and complement both the Federal park system and the Federal-aid highway system.

Travel along trunk highways has today become largely a chore, something to be accomplished in the shortest possible time. The pleasure of motion and viewing the countryside has been seriously lessened by the mixing of all kinds of traffic; by the frequency of intersections; and the uncontrolled use of adjacent lands which, by means familiar to all of us, has made most of the roadsides of our heavily traveled roads an eyesore and an abomination.

Since the parkway is, in its essence, an elongated park traversed by a road, the abutting property owners have no right of access, light or air. Traffic other than by passenger cars is excluded; and the traffic that is permitted gains access only at safe points separated by considerable distances. The properly planned parkway possesses beauty. Structures such as gasoline stations, restaurants, and overnight accommodations are

[3] F. L. Olmsted—California State Park Survey, 1929.

there to serve the traveler and only so many of them are permitted as he really needs. Increasingly, as on any good highway where traffic warrants it, the opposing lines of traffic are separated by a strip of varying width.

Even should parkway construction proceed for some time without any national parkway plan, there is little likelihood that any will be constructed where it is not justified. Yet the time is surely ripe to begin the planning of a national parkway system, so that it may develop in an orderly fashion; so that, so far as possible, the most pressing needs may be met first; and so that their designation and construction may be integrated with both the Federal and State park and highway systems.

The move toward a national parkway system is a move toward restoration, to the car owner, of those returns in pleasant driving, to which his payment of a variety of special and general taxes fully entitles him.

b. Trails and Trailways.—Millions of Americans have forgotten, or have never known, the pleasure of walking. On the one hand, the city never has made adequate provision for it, since pavements are not particularly attractive to the person who walks for the pleasure of walking. And the country road of 30 years ago has graduated into a modern highway where no provision has been made for the pedestrian, and where, even if such provision were made, the pleasure of walking would be largely destroyed by the close-by presence of noisy and odoriferous traffic.

Fine and useful as are the Appalachian Trails along the Appalachians from Maine to Georgia, the Long Trail through the Green Mountains, the John Muir Trail along the Sierras, and other trails of this type, they serve only a handful of persons. If walking, one of the best forms of recreation, is to regain the place to which it is entitled in the recreational scheme, the facilities for its enjoyment must be tremendously expanded. Men and women and children who live in cities should be able to go to the end of the bus or trolley line, and only a short distance from there to exchange the hard pavement for the resilient surface of a footpath leading across fields and through woods, "up hill and down dale." Successfully undertaken in scattered regions by trail clubs and walking clubs, the provision of walking facilities by such groups needs encouragement and support, as a means of supplementing the wilderness trails and the trails and paths that are developed in parks and forests.

The provision of trails was authorized as a proper function of the State by Massachusetts as long ago as 1924, but with little result in actual accomplishment there or by extension to other States. Established largely by right-of-way easement on private lands rather than by means of public ownership, but maintained by a public agency, public trails should be given recognition for their importance in any adequate recreational plan, and their use encouraged in every possible way. Desirable footpath or trail locations, in longer or shorter loops, or as connections between low-fare public transportation lines, can be found in abundance. These, when and if developed, can wisely be supplemented by the longer cross-country trails or paths, such as are being extended and mapped in several regions under the aegis of Youth Hostels. Such trails as these require, for their fullest usefulness, low-cost overnight housing such as that organization has arranged. To the walker on such trails belongs, not just the narrow strip of land on which the trail happens to lie, but all that he can see of meadow and woodland, hill and stream, to the farthest horizon.

Bicycling, as a recreational activity, has swept the country during the past few years; and our entry into war, with the resulting rubber shortage, has stimulated bicycling for utilitarian purposes. Consequently there is a need for bicycle trails in our parks and parkways and along our highways, as well as cross-country trails, for the purpose of providing the bicyclists with a safe and pleasant means of travel.

c. Routes of Water Travel.—Water travel by canoe, sailboat, and motorboat is gaining in popularity and provisions for this form of recreation should be made on lakes, streams, and canals, and along shore lines by making water routes accessible to the public and removing elements such as pollution, which hinder recreational use. The commercial usefulness of the canals, constructed by the hundreds of miles before and at the time of the advent of the railroad, has now almost completely disappeared; recognition of their potential usefulness as recreational routes has barely begun. Development of facilities for recreational use of the Illinois and Michigan Canal in Illinois was started with the beginning of the Civilian Conservation Corps in 1933. Similar development of the old Chesapeake and Ohio Canal along the Potomac above the Nation's Capital is now well under way. These two examples of long-neglected assets lying close to very large population centers may be expected to point the way to similar undertakings elsewhere. The canals, offering excellent recreational experiences both to the walker and to the canoeist, possess in addition unusual historic interest; they are reminders of a picturesque and often exciting phase in the history of American transportation; in many places, the canals and their appurtenances, such as the lock tenders' houses along the Chesapeake and Ohio Canal, possess unusual charm that adds enjoyment to their use.

Related in character to these is the Intracoastal Waterway, extending from Massachusetts to Florida,

active commercially—and nonetheless interesting for it—but used extensively also as a route for pleasure craft. It can logically be developed further as a recreational waterway by control of the use of its banks, provision of public areas for camping and picnicking, preservation of the many historic features along its course, and addition of facilities for servicing of small craft. The canal and the country easily reached from it are worthy of special study as to existing and potential recreational values and as to what needs to be done in order to develop the recreational usefulness of this charming and romantic water route.

d. Wayside.—This term is used to designate all those provisions of land, as parts of the complete highway, needed as stopping places to enable the traveler to derive greater enjoyment from use of the highway itself. It may designate simply a place off the traveled surface of the road where the motorist may pause to enjoy a pleasant view, or to read a historical marker, without endangering himself or others. It may mean a few shady acres where he may stop for a picnic lunch or just for brief relief, in pleasant surroundings, from sitting in an automobile. Some separation from the sight, sound, and smell of traffic is highly desirable.

As in the case of several other types of recreational areas, it does not appear desirable to set forth any absolute quantitative recommendations as to extent or frequency of location for waysides. Attractive views, or points of historic interest, may be numerous or rare, depending on the place. Rest and picnic places might well be provided ultimately along well-traveled trunk highways at intervals of 15 to 20 miles, with somewhat longer intervals on highways less traveled.

e. Preservation of Roadside Beauty.—Acquisition of attractive highway border strips, or use of scenic easements to obtain assurance of the preservation of natural features which contribute to the enjoyment of driving, offers an opportunity further to preserve highway recreational values for the user of the highway. Michigan and Minnesota, among the States, and the Society for the Protection of New Hampshire Forests, among the private organizations, have done notable work along these lines, worthy of emulation throughout the entire country.

The blight which has been laid on the American landscape by outdoor advertising of all kinds, from the snipe sign on a tree to the modern illuminated "landscaped" billboard which so often is planted in the foreground of the finest views from the highway, is one to cause any American to blush with shame. Outdoor advertising, designed to attract the motorist's attention, which, to just the degree that it is successful in accomplishing its purpose is a menace to safety on the highway, has no legitimate place in the rural or wilderness American scene. It can be eliminated or controlled, and by legal means.

The zoning of outdoor advertising out of residence and other locations by city or county zoning agencies is recognized as a constitutional use of the police power. The State, from which cities and counties derive their zoning power, can exercise in its own behalf any power it can delegate to any other governmental agency. Exercise of that power by passage of suitable State legislation should be urged upon State legislatures by all those agencies and individuals interested in preserving and restoring the amenities of the American countryside.

Administration of Recreational Lands and Facilities

An endeavor has been made thus far to indicate what is needed, if the recreational requirements of our people are to be met. A recreational plan possesses little significance, however, unless it is possible at the same time to indicate, on a logical basis, the part which the various types of agencies, Federal, State, and local, should play in providing and administering recreational lands and facilities.

At the two ends of the scale—the Federal Government and the municipality—there appears to be general agreement as to certain responsibilities. That the Federal Government should own and administer areas which qualify as national parks and monuments, few will dispute. It is wholly logical that in response to public need, and subject to proper coordination, the recreational opportunities offered by national forests, national wildlife refuges, and other Federal properties should be developed and utilized. Nor is there any important difference of opinion as to the responsibility and obligation of the municipality to provide needed parks, parkways, and play areas within its boundaries. It is within the vast field between these two extremes that we enter the realms of dispute and uncertainty.

There has been no attempt in this statement to set up a formula which would provide a uniform method of administration and jurisdiction. Taking into consideration the broad objectives of the recreational program, the acquisition, development, and administration of recreational areas must be fitted into a rather complex pattern. In general it is suggested that:

1. The Federal Government should direct the broad recreational plan for the Nation in consultation with State and local agencies.

2. Federal acquisition and development of areas of national importance from a recreational, scenic, scientific, or historic standpoint, such as national parks and monuments, are necessary.

3. Federal development of recreational resources of lands administered by the Government primarily for other purposes, such as forestry, wildlife, grazing, reclamation, and power, is necessary if these lands are to be administered with the maximum public benefit.

4. Federal cooperation with the States and their civil divisions is desirable in order to make available to them the benefits of the findings and experiences of Federal agencies and the other States and to provide adequate recreational facilities.

5. State governments should be responsible for acquisition, development, and administration of recreational lands needed primarily for the people of the State.[4]

6. Local governments, including all political subdivisions of the State should be responsible for supplying and administering day and week-end recreational opportunities for local residents.

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[4] In some of the so-called vacation States the provision of facilities to accommodate tourists is also an important consideration.

3. LONG-RANGE NEEDS FOR RECREATIONAL ACTIVITIES

The information necessary to project a complete recreational program in quantitative terms is not available. An attempt has been made, however, to outline in general terms the needs for various types of recreational activities and areas.

Activity Requirements

System Planning

The broad national, regional and state recreational studies should be continued and accelerated in order to complete the framework within which a public works program may be constructed. Thirteen of the States (California, Colorado, Iowa, Kansas, Montana, Michigan, Nebraska, New Hampshire, New York, Ohio, South Dakota, West Virginia, Wyoming) and the Territory of Hawaii have not completed even preliminary progress reports. In the other States which have completed their first reports, planning activities should be continued in order to keep the plans current and to study certain aspects of the recreational problem which have not been completed or undertaken thus far.

The State reports vary considerably in scope. Generally, they cover fairly well the situation with regard to existing facilities and administrative organizations concerned with recreation; and to a varying extent they discuss or touch upon recreational needs, potential areas, administration, legislation, finance, and such activities as organized camping, hiking, and winter sports. All of them contain recommendations for continuing certain phases of the work and undertaking additional ones.

During the development of the State plans it has become evident that certain problems cannot be determined adequately within State boundary lines. Each State plan must consider the existing and proposed facilities in adjoining States within reasonable distance of its borders as well as the nearby residents in adjacent States who may patronize its parks and recreational areas. Consideration must also be given to outstanding recreational resources, such as mountain areas and bodies of water, that are of more than State significance. The solution of such problems necessitates regional studies. As an initial step in this phase of the work, the National Park Service, in cooperation with the States and other Federal agencies concerned, is undertaking a study of the Central Southeastern region, which comprises the Tennessee and Cumberland Watersheds and the surrounding area affected by them. It is expected that this study will enable the State and Federal agencies to adjust their individual program so as to affect the proper coordination. A recreation study for New England is being made by the New England Regional Planning Commission and the National Park Service in cooperation with other Federal and State agencies. Similar studies should be made for other regions.

Various Federal land administering agencies, such as the National Park Service, the Forest Service, the Fish and Wildlife Service, the Soil Conservation Service, the Bureau of Reclamation, the Office of Indian Affairs, the Tennessee Valley Authority, and the War Department are developing plans for the recreational use of their lands. Although, except for National Park Service lands, recreational use is supplementary to the primary purpose for which the various areas have been established, they can and do furnish much in the way of recreational opportunities. The planning for such use must be coordinated and integrated with the State plans.

Area Planning

As rapidly as recreational needs are determined and specific areas selected to provide for those needs, master plans or general development plans should be prepared for each area. Such plans should show the general location of boundaries; existing natural and cultural conditions; the allocation of various portions of the area for such uses as picnicking, camping, intensive play, wildlife preservation and administration; and the location of proposed developments such as roads and trails, structures, camp grounds, service facilities, etc. Master plans are essential to orderly and economical development. In many instances lack of such plans has necessitated long delays in development programs and has resulted in costly mistakes. The preparation of plans, which requires lengthy and detailed study by trained and experienced personnel, should be undertaken well in advance of any development program.

Likewise, the advanced preparation of individual job plans and specifications for at least major developments such as roads, dams, and large structures is recommended.

Land Acquisition

Land acquisition is frequently a serious bottleneck in a public works program. Agencies concerned with

recreation at all levels of Government should be encouraged to acquire lands as rapidly as their need is determined. Advanced acquisition not only places an agency in a position to take immediate advantage of a new or expanded works program but it also frequently means a considerable saving in the purchase price.

Development

The provision of adequate recreational opportunity will require an extensive program of public works to make recommended areas and facilities available to the public. This will include a wide variety of projects such as roads and trails; water, power, and sanitary facilities; communication systems; fire breaks, look-out towers, and other protective measures; structures, including dwellings, administration, and service buildings, bathhouses, trailside museums, shelters, lodges, and cabins; dams; forestation; and soil-conservation work.

Administration

In order that the recreational areas and facilities developed may be utilized effectively and economically, administrative aspects, such as maintenance and management, leasing, issuance of permits, handling of concessions, personnel management, and public relations should be appraised and desirable practices determined.

Far too little attention has been given to recreational leadership and programming of administrative planning. Studies and demonstrations undertaken cooperatively by the National Park Service and other agencies indicate that our present facilities are receiving only a fraction of their potential use and that the proper type of leadership will greatly stimulate the effective utilization of the Nation's recreational facilities.

Area Requirements

Since recreation is a quality of living and an intangible but none the less important contribution to our national well-being, it is difficult to determine quantitatively the Nation's recreational needs. Through the Park, Parkway, and Recreational Area Study an initial start has been made, however, in determining the need for nonurban outdoor recreational areas and facilities. Many needed expansions of existing areas, locations where additional areas are needed, and the facilities that should be provided are listed and described in the State Recreation Study reports and in the National Park Service report referred to above.

Known requirements have been projected in accordance with the most reliable data and standards available to arrive at the estimates given in the following pages for six general classes of areas.

1. Municipal, including all areas within the corporate limits of municipalities:

In 1930 there were 3,165 cities of 2,500 population and over with a total population of 68,954,823. In the Municipal Park Study of 1935, 1,200 cities of this class with a total population of 54,775,188, reported 381,496 acres of municipal parks. Based upon the commonly accepted standard of 10 acres per 1,000 population, a total of 689,548 acres are needed for municipal recreation. Deducting the existing acres leaves 308,052 additional acres to be acquired. During the past decade the population increased by about 9,000,000 which, assuming the same ratio between urban and rural dwellers, would necessitate another 50,000 acres. The grand total of additional municipal acreage thus required is 358,052—say, 400,000 which would include some provision for smaller communities which in 1930 totaled more than 9,000,000 population.

2. Local nonurban, including metropolitan, county, and other local outlying areas which serve largely day-use needs:

There are some 258,000 acres in this class of areas, in addition to the county forests in Wisconsin which contain 1,738,000 acres. Based upon an estimated need of 5 acres per 1,000 population and on the assumption that 80,000,000 of our urban and nonurban dwellers would avail themselves of these recreational facilities, some 150,000 additional acres are required.

3. State, including State parks and related recreational areas and certain Federal areas which are primarily of State-wide or regional importance:

There are some 2,000,000 acres in this classification, exclusive of the Adirondack and Catskill State Parks which constitute the New York State Forest Preserve. Based on studies already made it is estimated that 4,000,000 additional acres are required.

4. Federal: The National Park System contains more than 21,500,000 acres dedicated to the preservation of scenic, scientific, and historic resources for the enjoyment of the people. The Forest Service has allocated some 100,000 acres exclusively to recreational use. This acreage consists of about 5,000 small tracts of land scattered throughout the national forests which have greater value for recreation than for any other use. Included in this acreage are camp grounds, picnic areas, resort sites, organization camps, winter sports areas, etc.

There are also some 300,000,000 additional acres of public lands in the national forests, national wildlife refuges, grazing districts, reclamation areas, the public domain, etc., which provide opportunities for such forms of recreation as camping, hiking, boating, hunting, and fishing. This paper merely recognizes their existence as an important factor in the over-all picture and does not attempt to predict future needs for such lands.

There are some 775,000 acres of private interior holdings in the national parks and monuments and approximately 2,300,000 acres in projects authorized by Con-

gress. There are some 33,500,000 acres of interior holdings in the national forests. Of this area, approximately 1,500,000 acres have recognizable recreational values, in addition to forest and watershed values, because of their location on or near important lakes, streams, or highways, or established recreational centers.

5. Parkways: Since parkways constitute a specialized recreational facility developed by all levels of Government and all types of parkways are used in varying degrees for everything from urban commuter travel to vacation travel, it seems desirable to treat them as a separate classification.

The Nation has some 1,300 miles of parkways, either completed or under construction, a very large portion of which is contained in the three Federal parkways (Blue Ridge, Natchez Trace, and George Washington Memorial) and the State, county, and municipal parkways in the New York metropolitan area. There are existing proposals for other Federal parkways, including extensions of existing ones, totaling some 4,000 miles, and numerous proposals for State parkways. It does not seem unreasonable to assume that the construction of up to 10,000 miles of parkway ultimately will be necessary.

6. Shore frontage: Studies have indicated that 10 percent of the shore line of our oceans, gulf, and major lakes and streams should be held in public ownership for conservation purposes directly related to recreation. To meet this objective it will be necessary to acquire some 1,500 miles of frontage on the Atlantic and Pacific Oceans, the Gulf coast and the Great Lakes. These holdings should be divided between Federal, State, and local governments; the determination to be made largely upon the use and significances of the individual areas.

4. COSTS AND BENEFITS

Costs

An estimate of the total cost for an adequate recreational plant presupposes a careful determination of recreational needs. After the needs have been determined, consideration must be given to such factors as land prices, materials and labor costs, and administrative expenses for land acquisition, planning, supervision, and other overhead items. It is essential also that developments be geared to the ability of public agencies and private individuals to maintain them properly. Many excellent facilities have been allowed to deteriorate because of poor or inadequate maintenance.

Benefits

The primary benefits resulting from a recreational program are those which contribute to the Nation's general welfare—the conservation of its recreational resources and the provision of recreational opportunities for its people. Programs for health, welfare, and education fall into a similar category.

Secondary to the principal objectives of a recreational program are certain economic benefits resulting from the establishment of these areas, such as watershed protection, the prevention of soil erosion, the protection of game supplies, the increase of business in neighboring communities, and increased land values.

The creation of an adequate recreation plant would provide an outlet for a great number of temporary jobs in the development program and many permanent jobs for administration and maintenance afterward. It also would stimulate private employment in providing for the needs of the park users while en route. In the post-war period, a park and recreation development program would be an effective and useful means of reducing unemployment.

Recreation can very properly be classed as a maintenance cost of living, together with sustenance, shelter, education, and health, because without it the will to live and the enthusiasm to produce usable goods would be lacking. How many automobiles would be sold exclusively for business reasons if there were no scenic highways or recreational areas to visit? The size of the industry manufacturing and selling sporting equipment is another indication of the importance of recreation to the American people.

The American habit of traveling for recreation has many profound results on our national economy. It tends to counteract the concentration of wealth in the eastern regions and around cities, because people from these concentrations of population go to the less densely populated areas for recreation and leave their money with the local residents who purchase the products of our industrial centers.

Various attempts have been made to evaluate recreation on the basis of estimating the expenditures of recreationists on vacation trips. These figures are impressive and some estimates arrive at $5,000,000,000 a year spent on food, lodging, gasoline, clothing, etc. Actually, of course, whatever people spend on a vacation or a recreational trip they do not spend at home and the increased business in Arizona due to the vacation travel of Illinois tourists means a loss of business in Illinois; however, it does stimulate manufacturing and business in Illinois.

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5. EVALUATION OF PUBLIC WORKS FOR RECREATIONAL DEVELOPMENT

Program Evaluation

The objective of a public-works program in recreation is to increase the national well-being through the conservation of our recreational resources and the provision of recreational opportunities. There are also certain resulting indirect benefits such as wildlife protection and supply, watershed protection, the provision of permanent jobs to administer and maintain the areas, stimulation to business in neighboring communities, and increased value of adjoining lands. Although these benefits do have a very real economic value, no method has as yet been devised to measure them in monetary terms so that they can be compared on a dollar and cents basis with other types of public works that produce vendible products. If it is determined that the preservation of a particular area is in the public interest or that the provision of facilities is required to meet the recreational needs of a given community, then it may be assumed that reasonable expenditures to accomplish such ends are justified.

Public works in the field of recreation should, of course, be coordinated with the programs in other fields. There are frequent opportunities to provide needed recreational facilities in connection with power, irrigation, flood control, forestry and wildlife projects with relatively little additional expenditure. Recreational facilities are not suitable or needed in connection with all such projects; however, coordination is essential to prevent duplication or the unwarranted devolepment of recreational facilities. It is necessary also that the programs of Federal, State and local agencies be properly coordinated.

It must be remembered that complete and integrated plans cannot be formulated within a short space of time, and that all long range plans should be flexible and subject to revision in the light of changing conditions and the availability of additional information.

Evaluation by Classes of Areas

Areas Requiring Primarily Preservation and Protection

High priority should be given to the preservation and protection of outstanding recreational resources, especially where such resources are in danger of despoliation or of being lost to the public. Danger of destruction of certain redwood forests by fire or the lumberman's ax, the loss of important historic or prehistoric sites through neglect, invasion of wilderness areas by roads, and the usurpation by private individuals of beach lands which are vital to a public-recreation program are examples where the situation demands prompt action.

Areas Contributing Multiple Benefits

As previously stated, projects for power, flood control, irrigation and forestry frequently offer opportunities for providing needed recreational facilities for relatively little additional cost. Greater public benefits at smaller costs are likely to accrue if provisions for recreation are considered and developed at the beginning rather than later as an afterthought.

Single Purpose Areas to Meet Recreational Deficiencies

A large majority of recreational projects would be included in this classification. Selection should be made on the basis of:

a. Local needs for recreational facilities.

b. Relative costs and adaptability of area to purpose.

c. Local unemployment and economic situation.

d. Sequence and timing, which involve such factors as land acquisition and progression of work.

Evaluation of Individual Projects

Protection Facilities

In the evaluation and selection of individual projects, high priority should be given to those which contribute to the preservation and protection of areas already in public ownership. Such projects include fire breaks, protection roads and trails, communication systems, water supply, sanitary facilities, administration and service facilities, marking of boundaries and fencing.

Day Use Facilities

Next priority should be given to projects required to meet the day by day recreational needs of the public, such as facilities for picnicking, swimming, boating, hiking, riding, skiing, nature recreation, and general and intensive play.

Overnight Accommodations

Camp grounds, organized group camps, cabins, lodges, and hotels serve fewer people, and require a greater capital outlay per user than day use facilities

in general. Other factors being equal this class of projects should be given last priority.

General Criteria for Evaluation

Certain general criteria should be applied to evaluation of all public works projects and programs for recreational development. Among these are the ability of the sponsoring agency to administer the areas and facilities, the willingness of the sponsoring agency to make financial contributions, the status and soundness of planning, the status of land acquisition for the project, and the suitability of the area for development through such public works programs as in the past have been operated by the CCC, NYA, and WPA.

PART V—PUBLIC WORKS AND WILDLIFE LANDS[1]

1. GENERAL OBJECTIVES OF THE FISH AND WILDLIFE PROGRAM

Since the earliest settlement of this country, the natural abundance of wildlife has played a vitally important part in providing a source of food and supplying in part an ever-increasing demand for furs. More recently the study or taking of wildlife by sportsmen has developed into an industry of considerable importance.

Recent inventories of wildlife indicate the vast nature of this renewable natural resource in the United States. The estimated value of the game and fur resource alone is roughly $1,150,000,000, and the yearly returns to the people of the country for harvesting the available surplus on a sustained yield basis amounts to somewhat over $100,000,000.

The value of this wildlife resource has been studied critically since the natural supply had been seriously reduced prior to the last decade by the increased utilization of land for agricultural purposes, by the pollution of waters destroying valuable fishery resources, and by the steady depletion of seed stock through a continued take in excess of increase. More recently the drought conditions of 1934 and 1936 contributed to the further reduction of some forms of wildlife through the elimination of vast areas of normal waterfowl habitat.

All wild animals are dependent on their environment for existence, and in this fact lies the key to any program designed to foster wildlife populations. The principal requirements for the maintenance of a wildlife population in the United States are the rehabilitation, development, preservation, and protection of suitable places for it to live. Fortunately, as these habitats are restored and hunting and fishing pressure held within reasonable bounds, wildlife increases. The objectives of the wildlife program are to conserve an adequate seed stock of wild animals in nature and to restore, develop, and protect a satisfactory environment to insure their preservation. With the attainment of these objectives, the following benefits of wildlife conservation will be realized:

(1) Rare or disappearing species of scientific importance will be preserved.
(2) Harvestable surpluses of wildlife will continue to supply man with definite economic return.
(3) People will continue to obtain the satisfaction of enjoying the presence of wild animals, birds, fishes, and all living things in the out-of-doors. This is probably the most far-reaching benefit of a conservation program.

In addition, the wildlife program entails the control of predatory animals and injurious rodents whose depredations exact a heavy toll of the livestock, game, and agricultural crops of the Nation.

Wildlife work involving habitat improvement is now being carried forward by various State and Federal agencies. The objective, whether primary or secondary, of all of their programs is basically the same—to restore a satisfactory environment for preserving an adequate seed stock and producing a surplus—but the methods employed in these programs vary.

Wildlife conservation projects fit closely into the land-use program, both from a regional and national planning standpoint. The number of areas in the United States on which the production of wildlife is the primary purpose is limited. Such work is carried out principally on land which has been set aside for refuges, including marshlands and bodies of water for fur or fish production. Certain inaccessible forested areas besides their basic use for watershed protection are so managed. Cut-over lands, and some desert lands of the Southwest, having little agricultural, grazing, or forestry use are, without organized management, primarily of value for wildlife.

Where wildlife is managed so as to contribute to recreational facilities, work is done to produce wildlife as a first priority, but with other land uses held in mind as important secondary considerations.

Where wildlife is considered a desirable byproduct of other land uses, it is fostered only as it contributes to or at least does not interfere with other uses of land. Work of this multiple-use type is done principally on agricultural land, and to some extent on grazing and forest lands.

[1] This statement was prepared under the direction of A. C. Elmer, of the Fish and Wildlife Service. Contributions were made by P. A. DuMont, of the Fish and Wildlife Service, H. L. Shantz, of the Forest Service, and W. R. Van Dersal, of the Soil Conservation Service.

2. TYPES OF DEVELOPMENT WORK NEEDED

In a program of work financed by the public and aimed at the conservation of wildlife, the principal activity is work on land or water designed to increase, improve, or restore wildlife habitats. In some instances this must necessarily be accompanied by appropriate legislation or the adoption of a more effective administrative procedure for attainment of the objective, and in all instances must be reinforced by legislation to prevent improper use or waste of the wildlife resource after it has been produced.

The majority of wildlife conservation projects are designed to improve lands for the use of wildlife and as such will involve the expenditure of considerable sums for such improvements as dams, dikes, and water-control structures necessary to establish permanent marshes and open-water conditions for waterfowl and other migratory birds; for fences to control grazing and trespass and to protect fully the lands against poaching and other unauthorized use on big-game, upland game or waterfowl areas; for roads, trails, and fire lines to facilitate administration and patrol, fire protection, and proper use of the lands; for administration buildings for housing personnel and equipment needed to administer the lands: for telephone and power line facilities; for food and cover plantings and other improvements designed to establish optimum habitat for all species of wildlife.

The wildlife conservation program is Nation-wide in its scope and it is carried out on various kinds of lands and with different degrees of intensity. The most intensive management is found on the national wildlife refuges, so designated by executive orders creating them on Federally owned or controlled lands. State game refuges are also so managed.

The program of wildlife management on refuge areas incorporates all feasible practices to produce and protect the maximum population and variety of wildlife. Many refuges have been established to benefit particular species, now rare, or requiring specialized habitat. Such projects in the past have had high priorities in programs of public works because of widespread public interest and benefits. More recently, refuges have been established primarily to benefit migratory waterfowl, to encourage fur animals, and to preserve indigenous big-game animals.

On areas other than refuges a large part of the wildlife work to be done can be carried on most economically in conjunction with other types of projects; i. e., forestry, soil conservation, range conservation, and reclamation. The integration of wildlife work with such land programs not only accomplishes limited wildlife management more economically but also results in more widespread application of conservation measures.

It is desirable that persons trained in wildlife management be assigned to work with local and State land-use planning groups, such as the county agricultural planning committees and State planning boards, to assist in the proper integration of wildlife measures with other land-use practices.

Prerequisites to Programming

In order properly to develop a program of wildlife conservation projects, considerable information must be assembled, correlated, and studied to determine the relative values of various projects, their geographical location with respect to the life zone of animals and flyways of migratory birds, their importance in regional development. This preparatory work involves research and surveys, legislation, purchase of land, and planning for the participation of appropriate Federal, State, and local agencies.

Surveys

Research in the wildlife field has been carried on actively by various State and Federal agencies and in colleges and universities for many years. This research will supply much of the necessary background for the successful prosecution of a large-scale public works program. Additional surveys will be necessary in many parts of the country, but on areas proposed for wildlife refuges, hydrologic studies and topographic surveys as well as data on availability of land and its probable cost, in most cases still are required. Where the uses of the land other than for wildlife determine major work to be done, the soil surveys, land-use capability maps, aerial photographs, forest surveys, and other surveys concerned with land planning will, in many instances, provide sufficient data upon which to base a wildlife conservation program.

Legislation

In 1900 only nine States prohibited all spring shooting of migratory waterfowl, and during the following decade only five more States enacted such laws. It became more and more apparent that, since these birds recognized no State lines in their migrations, nesting, and feeding, a law national in application was necessary for their protection.

Such a law was passed on March 4, 1913 when Congress enacted the Migratory Bird Act, conferring upon the United States Department of Agriculture the authority to adopt regulations fixing closed seasons. The constitutionality of this legislation was challenged in the courts and it was followed by the Treaty with Great Britain in 1916, and the Migratory Bird Treaty Act of 1918. A similar treaty was concluded with Mexico, in 1936, with subsequent Amendment of the Treaty Act. The Migratory Bird Conservation Act of 1929, and the Migratory Bird Hunting Stamp Act of 1934 have facilitated the development of a continental refuge system as provided in the treaties.[1]

With the passage of the Coordination Act of 1934, the responsibility of the Federal Government for the preservation of wildlife was broadened by providing for close cooperation of various "Federal, State, and other agencies in rearing, stocking, and increasing the supply of game and fur-bearing animals and fish, in combating diseases, and in developing a Nation-wide program of wildlife conservation and rehabilitation." The act also authorizes "making such investigations as are deemed necessary to determine the effects of domestic sewage, trade wastes, and other polluting substances on wildlife, with special reference to birds, mammals, fish, and shellfish, and to make reports to the Congress of such investigations with recommendations for remedial measures. Such investigations shall include studies of methods for the recovery of wastes and the collation of data on the progress being made in these fields for the use of Federal, State, municipal, and private agencies."

The act further provides that "whenever the Federal Government through the Bureau of Reclamation or otherwise, impounds water for any use, opportunity shall be given to the Bureau of Fisheries and/or the Bureau of Biological Survey [2] to make such uses of the impounded waters for fish-culture stations and migratory-bird resting and nesting areas as are not inconsistent with the primary use of the waters and/or the constitutional rights of the States. In the case of any waters heretofore impounded by the United States, through the Bureau of Reclamation or otherwise, the Bureau of Fisheries and/or the Bureau of Biological Survey,[2] may consult with the Bureau of Reclamation or other Governmental agency controlling the impounded waters, with a view to securing a greater biological use of the waters not inconsistent with their primary use and/or the constitutional rights of the States * * *"

[1] The authority contained in these acts has been transferred to the Secretary of the Interior, by the President's Reorganization Plan No. II.
[2] Now the Fish and Wildlife Service.

General authority was granted to the Secretary of the Department of Agriculture by the act of August 11, 1916 (39 Stat. 476; sec. 683, title 16, U. S. C.) for the protection of wildlife on National forests as follows:

> The President of the United States is authorized to designate such areas on any lands purchased by the United States under the provisions of sections 513 to 519 and 521 of this title (the Weeks Act), as should, in his opinion, be set aside for the protection of game animals, birds, or fish. Whoever shall hunt, catch, trap, willfully disturb or kill any kind of game animals, game or nongame birds, or fish, or take the eggs of any such birds on lands set aside, or in, or on the waters thereof, except under general rules and regulations as the Secretary of Agriculture may from time to time prescribe, shall be fined. * * *

Laws affecting the conservation of wildlife on agricultural land include a considerable number enacted to foster better land use, soil conservation, flood control, and related activities. These activities are carried on under the Soil Conservation Act of 1935, the Flood Control Act of 1936, the Cooperative Farm Forestry Act of 1937, title III of the Bankhead-Jones Farm Tenant Act, the Water Facilities Act of 1937, and related amendments, appropriation acts, and regulations.

While other management methods are necessary in maintaining and in building up wildlife population, the protection of it from excessive take, particularly at times when numbers have been reduced through disaster, is most important, and numerous laws have been passed empowering State and Federal agencies to protect wildlife species. Gradually these laws are being amended to authorize the establishment of open hunting, trapping, and fishing seasons based on actual surveys of available surpluses. These surveys in many instances are pointing the way toward unification of State laws designed to protect the same wildlife species.

Valuable commercial fisheries, except where regulated under international treaty or under Federal laws, as in Alaska, are regulated under individual State laws which generally are incapable of dealing adequately and promptly with the diversified management problems of the commercial fishery resources. This outmoded type of regulation in almost no instance has been able to balance withdrawal against natural or artificial replacement, nor to provide for economical utilization of available stocks. Provision of discretionary management systems through the establishment of fishery commissions by means of interstate compacts or international treaties, is a vital necessity for the effective utilization of all the major commercial fishery resources.

Since 1900, when the Lacey Act was passed, the Federal Government has been charged with the responsibility of regulating the introduction of American or foreign birds or animals in localities where they have not heretofore existed. Furthermore, the Lacey Act

prohibits interstate transportation of wild animals or birds killed contrary to State law.

Although a large program could be developed under various existing authorizations, it is doubtful whether all activities could be expanded to their optimum limits. Certain change in language and possibly minor modifications in present enabling acts of the various Federal agencies may be needed to permit fullest participation in a wildlife works program. A study of needed legislation, therefore, should be undertaken in the near future to provide a guide to the programming of development projects.

Land Purchase

Where land ownership is the limiting factor in a works program for wildlife conservation and development, the purchase of additional lands for wildlife is necessary. Purchases are required primarily to develop the national wildlife refuge system, as well as to make occasional needed adjustments in wildlife conservation operations on other lands.

Several millions of acres of land should be acquired and made suitable for wildlife. Approximately 4½ million acres of strategically located land and water remain to be set aside and developed for waterfowl use alone, in the southern wintering grounds particularly on the Gulf coast, in the North, in the primitive nesting grounds of the Great Plains, and along the four principal flyways at 250- to 300-mile intervals. The acquisition of this acreage is made necessary by the loss to waterfowl of the use of approximately 120 million acres of marsh and swamp land which were drained under the provisions of the Swamp Land Act of 1850 or through other drainage operations. At present there are probably less than 30 million acres of water habitat in the United States of even remote use to waterfowl.

There remain large gaps in the long-time national upland and big-game refuge program which must be filled by public acquisition of land in order properly to protect the ecological habitat necessary for the preservation of indigenous big-game animals and upland game birds.

Scattered throughout the United States and its possessions there are sizable areas of land which, because of their location, type of soil, topography, and other characteristics, have little surface value except for wildlife production and which, by development, can be made to produce revenues from this use far in excess of the cost of development and greater than would be possible from any other use of the land. These lands are definitely nonagricultural in character and have no value for industrial uses; they should be acquired and developed by Federal, State, or municipal agencies for wildlife use. As new land is purchased, the various types of work required to condition it for wildlife can be expanded.

Participation of Public Agencies

In planning the wildlife public works program consideration should be given to how the Federal, State, and local agencies may participate through contributions of professional services, material, labor, and funds. These contributions may vary from place to place, but they should be agreed upon well in advance of actual operations. Any estimates of required legislation, surveys, purchases, and appropriations will depend upon and must be correlated with data resulting from a study of the degree and type of participation which may be expected from the various agencies.

The Fish and Wildlife Service is the agency of the Federal Government primarily responsible for the protection of the Nation's wildlife resources. In this capacity it studies all forms of vertebrate wildlife; surveys the major biological regions of North America; studies wildlife food habits; makes observations on the distribution and migration of birds; carries on propagation experiments with fur and game species; and investigates wildlife diseases. It acquires and maintains national wildlife refuges, and administers the wildlife conservation laws. The fisheries work of the Service comprises the propagation, salvaging, and distribution of food fishes to suitable waters; inquiry into causes of fluctuations in abundance of food fishes in coastal and inland waters; study of fisheries methods and of utilization of fishery products; collection and compilation of statistics of the fisheries; administration of the fisheries of Alaska; administration of the Black Bass and Whaling Treaty Acts, and the Act Authorizing Fishery Cooperatives; conduct of a market news service; and cooperation with other agencies in fishery programs.

Wildlife is one of the resources for whose management the Forest Service is responsible in national forests, which are located in 40 States, and in Alaska, and Puerto Rico. The National Park Service is responsible for protection of all forms of wildlife in the parks and monuments under its jurisdiction in 41 States, Alaska, and the Hawaiian Islands. The Soil Conservation Service incorporates wildlife management practices on Federal lands under its jurisdiction, and on lands within the conservation districts and soil conservation demonstration areas. Much of the work performed by the Civilian Conservation Corps benefits wildlife. Twenty-eight of the reservoirs in Federal reclamation projects have been designated by Executive Order as national wildlife refuges. The Office of Indian Affairs has set aside roadless areas and wilderness areas covering several million acres to provide an environment favorable to wildlife. Attention is given to wildlife on

the millions of acres administered by the Grazing Service in its grazing districts. The AAA program of shifting from soil-depleting crops to legumes and grass is beneficial to wildlife. Reservoirs, resulting from basin developments such as that of the TVA, and numerous Corps of Engineers flood-control projects, frequently provide improved conditions for fish production and migratory waterfowl.

In most of the States, the State fish and game departments are responsible for developing and administering the wildlife resources, and for regulating the take of wildlife surpluses. County agents advise on agriculture practices which may benefit wildlife. Supervisors of soil conservation districts, boards of county commissioners, and county land-use planning committees, which are now responsible for much of the local land-use planning on agricultural lands, are giving attention to wildlife problems.

Program of Public Works

The development of the wildlife habitat requires many types of public works projects. Chief among these are the following, arranged in approximate order of economic importance, based upon values as outlined in the section on criteria. This work may be done on either public or private lands.

Construction and Development of Lakes, Ponds, Reservoirs, and Watering Facilities

This work includes construction of dams and other water-control structures, fencing of pond or lake environs, and planting of proper vegetation where required. Such water facilities would be developed for production of waterfowl, food fishes, fur, big game, and upland game.

1. *Production of waterfowl.*—Marsh areas, not to exceed 3 feet in depth, are required. Sufficient water supplies are necessary to maintain a nearly constant water level in the marsh for food production. Particularly in the West, where seasonal evaporation is great, this will require an adequate reserve supply of water. Marshes must be fenced to protect adjacent marginal areas against erosion and overuse by stock and to protect the marginal food supply and the nesting and rearing areas. Unless erosion is controlled, the resulting turbidity of the water will retard the growth of or eliminate aquatic plants. Whenever possible, fencing should include a marginal strip surrounding the marsh for nesting purposes.

2. *Production of food or game fish.*—This program is important especially in regions of low income and where human diet deficiencies have been demonstrated. Marsh pond or shallow bay areas, with a depth not to exceed 3 feet, are required for fish spawning and rearing areas. These shallow waters will provide suitable feeding areas if turbidity of the water is prevented by proper erosion-control measures on the banks and headwaters. The installation of screens, fishways, or other devices is needed to prevent loss of fish in irrigation diversions and to enable fish to pass over obstructions in streams.

3. *Production of fur.*—The annual harvest of skunks, weasels, opposums, rabbits, muskrats, minks, foxes, and beavers amounts to millions of dollars. All are benefited by increased water facilities producing an increased food supply. As a general rule, conditions suitable for the maximum production, feeding, and rearing of waterfowl are also ideal for fur animals. Muskrats and mink require shallow marsh areas. When kept within the proper balance, so that excessive damage does not occur to earthen water-control structures or to vegetative stands, muskrats prove beneficial in waterfowl production by the creation of open-water pools and by the provision of mounds for nesting sites.

4. *Production of big-game and upland game.*—The development of ponds or tanks serves to increase the population of mountain sheep, deer, antelope, turkey, sage grouse, quail, and doves. Such development, while of great benefit in all parts of the country, is particularly important on grazing lands of the West. The proper distribution of these tanks results in better utilization of forage and decreases predation. It frequently provides a range where none could otherwise be utilized on account of lack of water. Tanks at higher elevations are of great use to big-game species. Those in the valleys also benefit stock. When a tank is used by stock, fencing of water lanes often is necessary to safeguard the tank and protect the animals.

Refuge Development

The Federal Government's responsibility for protecting certain forms of wildlife now rare or threatened with extinction requires the selection of refuge areas where greatest protection will be afforded.

Extensive marsh areas, in units of 50,000 acres or more, are needed in the South as refuges for waterfowl wintering grounds. Smaller resting and feeding refuges should be provided along the four principal migration routes—the Atlantic, Mississippi, Central, and Pacific flyways. Larger marsh areas or combinations of several smaller marshes, closely grouped for administrative purposes, are required in the Northern nesting zone.

Public works projects for development of wildlife refuges offer excellent uses for manpower in regions frequently lacking in other work programs, and include construction of water control structures; restoration of nesting areas by planting desirable food plants; pro-

viding supplementary food patches and shelters; fencing and posting to protect against misuse; construction of trails and roads for purposes of maintenance, patrol, and fire protection; erection of fire observation towers; and buildings for satisfactory administration of these areas.

Stream and Streambank Development

This includes fencing and, in some cases, planting of streambanks, both to provide wildlife habitats and to prevent streambank erosion. Where pollution and siltation are not factors, additional work benefiting wildlife is possible, such as building of pools, use of log and rock deflectors and dams for fish production; planting of willows and poplars to provide for subsequent beaver placement in appropriate localities; increased cover for fur animals; and planting of broad-leaved trees to provide shade over pools to maintain lower temperatures, particularly in trout streams.

Sewage and Industrial Waste Disposal

Federal funds already have been extensively provided for the construction of pollution-control and abatement devices. This problem has become so acute, especially in the present emergency, that public works projects of this type command a very high priority. These projects are highly important to wildlife conservation. In evaluating projects for construction of plants for the treating of raw sewage, for example, the danger to health and the loss of municipal water supplies, as well as the loss of a valuable fishery resource must therefore be considered. The sealing of abandoned coal mines is another important protective measure against destruction of fish through the polluting of streams by waste acids. Still another is construction of devices for controlling industrial pollution. Pending the enactment of curative legislation, this problem, because in most instances it involves private industry, is most difficult of solution.

Restoration of stream bottoms by removal of accumulations of sawdust, pulp, or other materials that inhibit the growth of bottom food organisms, is vitally necessary for fish production.

Management of Salt Water And Fresh Water Commercial Fisheries

Important investigations, in many instances equally applicable to salt or fresh water fisheries, can be facilitated by public works projects to provide boats, equipment, and manpower. Projects for the alteration of boats already under construction, or the transformation of boats not needed after the present emergency, will provide employment for some of the workers in an industry that at present is expanded far beyond normal.

Oyster Culture and Oyster Farming

Large numbers of men can be used profitably to preserve and encourage the growth of the valuable oyster resource. Their work would consist of improving the yield of natural oyster bottoms by improving the nature of the bottoms, by thinning and uniformly distributing the clutch, and by introducing better methods of collecting spat; applying scientific methods of controlling starfish and other oyster pests; and developing coastal areas for seeding as oyster farms on a commercial scale. Some measure of local participation probably will be required in oyster farm development since this work, designed to benefit State-owned waters, will provide improved fishing for private industry.

Forest Development

Reforestation and other land management measures to favor forest production are important in producing new wildlife habitats. Forest development work includes cuttings designed to provide openings suitable for the production of deer browse. Plantings for deer food can also be made in old orchards, along old log roads, fire trails, and other habitats suitable for forest wildlife. This activity should be restricted principally to public forest land and must be in accord with sound silvicultural practices.

Range Management

Inclusion of developments to benefit wildlife in a range program frequently offers opportunities to expand public works projects. The principal requirements for big game and upland game are similar to those for domestic livestock and developments for livestock also benefit both the range and the wildlife dependent upon it by securing a better distribution of grazing pressure.

Research

A public works program need not involve any extensive or long-time research work. Ordinarily, specially trained personnel and sufficient funds to cover several years are required in a research program. Where the fundamental purpose of a program is to provide employment in an emergency period, time and lack of trained men may seriously handicap research.

The enactment of laws protecting wildlife has, however, imposed a responsibility for research on which to base the management of the wildlife resource.

The wildlife research program being carried on by the various State and Federal agencies is furnishing a vast amount of information. Until recently, most of the studies were conducted on public lands. A research program for obtaining information of general applica-

tion must take into account privately owned land, as well.

Continuing programs of biological and statistical research form the basis of proper management of commercially utilized wildlife and fishery resources. Types of research for which there is an urgent need to facilitate the fullest scope of post-war public works projects will include the following:

1. Forest-range wildlife management studies on carrying capacities, possible competition between livestock and wildlife species, effect of disease, and effect of predators.

2. The management of fur animals in the wild, including the securing of information on primeness, as a basis for uniform laws permitting harvest of highest economic return; the relationship of land use for fur animals to other types of land use; the relationship of fur animal management to waterfowl management, particularly on the Gulf coast where competition for winter food supplies is important; and the establishment of management areas for special studies.

3. Investigations of the best methods for control of species harmful to the Nation's food supply, including predatory animals, rodents, and destructive birds.

4. Studies to determine relationship between insect pests and wildlife populations.

5. Studies of the ecology and management of marsh areas, to determine the best and most economical methods of restoring marsh conditions for maximum production of wildlife species.

6. Studies of experimental fishing gear to promote efficiency of capture; studies of methods of handling and processing of fish to prevent waste through spoilage; and studies of diseases and predators of commercially valuable species.

7. Studies of oyster culture, including life history, population, and migrational studies; and surveys of spawning, nursery, and feeding grounds.

8. Food fishery investigations to develop and recommend protective, prohibitory, and precautionary measures for the preservation and rehabilitation of aquatic biological resources.

9. Studies to determine feasible methods of producing food fish in small agricultural ponds.

Education in Wildlife Requirements and Sound Management Technique

Facilities for transmitting the results of wildlife research from those conducting it to the individuals for whom it is intended are inadequate. The extension-service plan used so successfully by the Department of Agriculture and by the State agricultural colleges to make known to farmers the facts and methods developed through research and experimentation has amply demonstrated its value. Wildlife management methods that have been found to be essential to sound land-use practices are being incorporated into land-use plans by the extension services, as well as by many other State and Federal agencies. The dissemination of information concerning these management methods to the private landowner is one of greatest needs in wildlife conservation at the present time. Its importance may be better understood when it is realized that 80 percent of the Nation's crop of game birds and fur-bearers is produced upon privately owned lands.

Priorities

While the items in the program of work enumerated above are presented in the approximate order of economic importance, these priorities are conditioned by the objectives of the agency administering the works program. For example, to a State conservation department responsible for an important fishery resource, projects improving fishery conditions probably would be more important than those dealing with fur management. Conversely, to the Federal Fish and Wildlife Service the establishment, restoration, and development of wildlife refuges is one of the most effective means of fulfilling its responsibility in protecting migratory waterfowl and other wildlife.

3. BENEFITS AND COSTS

Benefits

The benefits accruing to the public as a result of wildlife conservation work, although possible to measure in part in financial terms, are for the most part intangible.

It is not difficult to measure costs and benefits involved, for example, in the production of fish in lakes and ponds, or in the harvest of fur. On the other hand, such measurement cannot be applied to work designed to save a wild species from extinction, although no one denies the public desire and responsibility for this type of activity.

Similarly the justification for other wildlife conservation projects cannot be measured in monetary terms, but is adequately demonstrated by the powers of such projects to attract visitors. For example, upwards of 300,000 persons frequent one of the larger refuges in Oklahoma each year for the primary objective of observing buffalo, elk, deer, and other game animals and, incidentally, to use for picnicking and recreation the lakes and ponds developed to provide water for wildlife.

Generally speaking, while the economic benefits to be derived from wildlife projects may be of secondary consideration, the social benefits are likely to be of the utmost importance. Wildlife and recreation projects are extremely important from the standpoint of leisure and vacation requirements of the people.

Benefits to be derived from wildlife conservation and development work may be classified into two general categories—economic and social.

Economic Benefits

Direct economic returns greater than costs have been clearly demonstrated where fish are produced in ponds, and to a lesser extent in streams. Generally speaking, more pounds of meat can be produced per acre of pond water than per acre of pasture. The economic value of the commercial fish and shellfish resources and their indispensable role in the food economy of the Nation are measurable. For some species that provide a large annual catch no financial outlay, other than for biological and statistical research and for law enforcement, is necessary. Direct returns can also be shown in connection with the production of fur animals in the wild, provided management measures employed are not overintensive. Similarly, profits can be shown from the sale of hunting and fishing privileges through licenses, on certain types of land and water, provided management practices are adjusted closely to abundance, so that the greatest possible annual take consistent with the abundance and maintenance of the various species is permitted.

The indirect values of wildlife production are more difficult to measure. The stimulation of business through the twin activities of hunting and fishing runs financially into hundreds of millions of dollars.

Fisheries Products

The aquatic food resources of the Nation are of great economic importance. From the nearby off-shore banks, from the coastal marine waters and estuaries, from the Great Lakes, and from the major river systems, there are produced annually 4,000,000,000 pounds of fishery products worth $90,000,000 to the original producers. This supports a commercial industry which, including investments in fishing equipment and also in the independent industries, is valued at $1,000,000,000. Approximately 250,000 persons are dependent on this industry, located not alone along the coastal waters but on inland waterways as well.

Fishery products provide an economical source of proteins and minerals of high dietary value. They also yield vitamins in concentrated form and thus are essential to a well-balanced healthful diet. In addition to the food supply, the fisheries yield great quantities of fats and oils, fertilizers, and several score other products valuable to the arts and industries.

The value and utility of managed fish ponds have been well established. Farm fish ponds stocked with suitable varieties of fish and fertilized much the same as field crops are fertilized, have produced 400 pounds or more of edible fish per acre per year.

Fur Resources

The annual catch of fur animals in the United States is estimated to be about $40,000,000 to $45,000,000 and the retail sale of fur products reaches approximately $275,000,000 annually. Fur is an important commercial commodity, and more of it is consumed in the United States than in any other country in the world. It is estimated that there are 40,000,000 fur animals in this country and that the annual take in the wild is about 8,000,000 animals. Probably in no field of wildlife management is the harvest of surpluses done so completely by the individual landowner as in the harvest of fur animals.

Recreational Values

In our coastal and interior waters, angling, which is engaged in by upwards of 12,000,000 persons, is a most important form of outdoor recreation. Although no licenses are required for angling in vast areas of the coastal waters and in the Great Lakes, the sale of nearly 8,000,000 fishing licenses or combination hunting-fishing licenses brought a return of over $10,800,000 to the States in 1939. The economic values of sport fishing are difficult to assess with certainty, but they are very large and their value in promoting the health, welfare and morale of our people is beyond estimation. Many thousands of people rely on angling to provide a substantial portion of their food supply. To this segment of the population recreational values of fishing are secondary, but still extremely important.

Sportsmen paid almost $13,000,000 for more than 7,600,000 hunting licenses or combination hunting-fishing or hunting-trapping licenses in 1939, the latest year for which figures are available. Expenditures of hunters for license fees and for transportation, board, etc., estimated conservatively at $25 per man, have totaled nearly $200,000,000 in some years.

No satisfactory yardstick has been devised to measure the economic importance derived from nature study or the satisfaction gained by people in conserving wildlife except that based upon the money expended enjoying these activities. No figures are available as to the amount of money spent for cameras and film for wildlife photographs, or by the tourists who seek out places where they can simply watch the wildlife. It is known that these values do exist and that any estimates probably would be in terms of millions of dollars.

Water Conservation

The constantly decreasing area of inland waters has had a marked effect, not only on wildlife, but upon the many branches of agriculture, and upon municipal and local water supplies. The restoration of former water areas, together with new impoundments constructed primarily for wildlife benefits exert a pronounced effect in reestablishing local ground waters.

Control of Erosion

At no other time has the need for the conservation of our natural resources been as apparent or as clearly recognized as it is at present. The wasteful destruction of the basic resource, the soil, has proceeded at an ever-increasing rate within recent years. Much of the original vegetation of the country has been removed, and as a consequence, not only has soil become increasingly subject to erosion, but wildlife, being dependent on vegetation for existence, has also become severely depleted.

The same forces that cause soil losses have destroyed wildlife habitats. The removal of the vegetative cover has permitted washing away of topsoil, and this in turn has prevented the return of vegetation and the consequent restoration of wildlife. It is only natural, therefore, that revegetation should be relied upon to conserve soil, and since the same vegetation can be made to provide more wildlife habitats, it is possible to conserve two resources with one operation.

A program designed to control soil erosion on the headwaters of many of the rivers is a first essential to restoring the capacity of these waters to produce fish and wildlife. Soil conservation and restoration are basic needs on many areas and must be met before a biological restoration program will have any chance to succeed.

Benefits of Insect, Rodent, and Predator Control

An indirect value which cannot yet be accurately measured is that resulting from the destruction and suppression of various pests by wildlife. This includes the useful work of a great host of insect-eating birds valuable because of their continued repressive action on insect pest populations. It includes the useful services of hawks and owls that destroy rodents, the activities of some carnivorous and insectivorous mammals, and the work of fish that feed upon larvae of undesirable pests, including carriers of human disease.

The size of the problem of controlling injurious field rodents and rabbits, especially ground squirrels, prairie dogs, pocket gophers, kangaroo rats, and jack rabbits can be appreciated when one contemplates the vastness of the territory over which these animals range. They are found, for example, in nearly all parts of the 11 western range States which have an area of 761 million acres.

The problem of controlling rodents is not confined entirely to the West. The estimated annual loss from house rats is $189,000,000. Most control operations are carried out through cooperative arrangements whereby the States, counties, livestock associations, and farm associations supply approximately 75 percent of the funds.

Insofar as the predatory animal work is concerned, the major efforts of the Government have been directed against one species—the coyote.

Social Benefits

The social values are the most intangible of all wildlife values, yet they have been, in the long run, the most impelling. The simple fact is that people enjoy

seeing wild creatures. They are willing to pay for the privilege, provided the costs are within reason.

Aesthetic values attach to songbirds, to wildfowl, to rare and vanishing species, to big-game animals, to carnivores such as mountain lions and bears, and to many other types that may also have considerable economic value. There is no doubt that the preservation of species near extinction or liable to disappear if not protected, is a responsibility of Government. There is no other body capable of assuming such a charge, a fact which has been clearly recognized by the governments of all civilized nations.

Recognition of the value of big-game animals to the Nation has resulted in the establishment of national preserves and ranges for the perpetuation of distinctive North American forms. But for the protection afforded by these preserves, by the national parks, and by State refuges established for similar purposes, several species of big game that in years past inhabited in countless numbers the Great Plains and other regions, would have become extinct.

Costs

For the most part, the cost of wildlife conservation development will vary in accordance with the scope of the program, being relatively low on private agricultural lands, where such development is secondary, and probably highest on Federal lands to be developed for wildlife refuges. The Nation-wide requirements of wildlife refuges already have been set forth [1] by the Fish and Wildlife Service and the Forest Service.

To summarize, it has been demonstrated on existing wildlife conservation areas that for the biological, social, and economic reasons outlined above it is generally advantageous to the public welfare to increase wildlife populations. Since the public interest and responsibility is more clear in certain cases than in others, certain criteria to evaluate types of public works for wildlife conservation and development are required in order that funds may be expended most effectively to meet this responsibility.

[1] Planning for Wildlife in the United States, Part IX, Report of the Land Planning Committee, National Resources Planning Board, 1935.

Conformity With General Plans

Projects must be appraised in terms of a project's conformity with local, State, and regional development plans, and of its part in a national program of wildlife conservation and development.

Criteria for judgment of work priority should be based upon a number of points. Determinations should be made primarily on the basis of wildlife distribution, by benefiting species within their normal range and habitat. Proper wildlife management incorporates the best land-use practices and generally any land-use public works project, with only slight modifications, will result in increased benefits through the production of wildlife surpluses. Therefore, additional consideration should be given projects that include development for wildlife. Due to the public privileges, through licenses, of harvesting surplus wildlife, consideration should be given to work proposed for publicly owned or controlled areas, such as Federal and State refuges and sanctuaries, or wildlife restoration projects on which development is necessary to make the lands produce and maintain maximum wildlife populations. Of high priority are projects designed to produce food or supplementary income for families with low incomes in areas where living conditions are generally poor and where wildlife work can be undertaken partly to alleviate such conditions.

Projects designed to save wildlife species from extinction should also be given high priority. These should be understood to include projects to restore and protect suitable habitat for breeding, feeding, and rearing the young. Public works projects for the control and correction of pollution should receive high consideration because of their benefits in improving water supplies, in restoring habitat for fish and fur animals and production of food for migratory waterfowl, and in providing increased recreational facilities.

In any wildlife conservation program, proposed work should be evaluated upon the basis of its adequacy in preserving a seed-stock and in restoring suitable habitat for increasing production. As great consideration should be given to programs which will result in wildlife for the benefit of people whose greatest satisfaction results from the presence of wild animals, birds, fishes, and all living things in the out-of-doors, as to programs designed to provide a harvestable crop with definite economic return. Any wildlife conservation project should indicate the species or groups of animals, birds, fishes, or other forms that are expected to be benefited. Its proposed purpose, whether the development of a breeding and rearing area, resting and feeding grounds, or combination of these types of areas, should be stated. Whether wildlife conservation is the primary or secondary purpose of the project and the type of use anticipated for the area (refuge, public recreation area, or public hunting area) should be indicated.

The Cost-Benefit Ratio

For the most part the evaluation of wildlife conservation projects must deal with intangible benefits such as recreational use, hunting and fishing, or the sport of observing wildlife in the out-of-doors. However, on most projects direct benefits in the form of harvestable products of fish and fur animals are measurable and in many cases are sufficient themselves to justify the cost.

These benefits, whether computable as direct economic returns, or less tangible, may be counted as additional benefits from projects for which wildlife conservation may serve as a secondary purpose.

Justification for some public works projects for wildlife conservation lies largely in the increased efficiency which results from such projects in the program of the Federal Government to protect migratory birds; a responsibility imposed by treaty between the United States and Great Britain.

Financing

Most of the Nation's fishery resources are public property, and both fish and game usually are so considered until taken; therefore a high degree of public participation in their preservation and development is justified. Since birds and many varieties of fish migrate over vast areas, crossing many State lines, the responsibility of the Federal Government in financing public-works projects for these types of wildlife is relatively heavy.

The Federal Government should pay the costs of developing refuges on Federal land, and the costs of stream-bank and stream-bottom improvement along navigable streams. The States should pay the cost of development of wildlife areas on State lands, but when such areas are used in part by the general public for hunting, the harvesting of fur, or other purposes, some Federal contribution is justified. Federal expenditures on State lands, however, should be conditioned on compliance with existing Federal requirements as pre-

scribed in the Federal Aid to Wildlife Restoration Act (50 Stat. No. 917). Under this Act, the Federal Government and the States have initiated a limited program of wildlife restoration work with a joint contribution of funds, 75 percent being provided by Congress and the remaining 25 percent, by the respective States. Funds are obtained through a 10-percent excise tax on sporting arms and ammunition.

Timing

The lowest known point in the number of migratory waterfowl was reached about 1935. A long continued decline in waterfowl population was caused by drainage of marshes, increased efficiency of guns, and improvement of roads, which permitted increased numbers of hunters to reach remaining hunting areas. During the drought years of 1934 and 1936, conditions on the Great Plains were at their worst, not alone for migratory waterfowl, but also for fur animals and fish.

The restoration of habitat suitable for wildlife requires the restoration of food and cover. In most instances this involves impoundment of water which may require some time before levels stabilize. The Federal program of waterfowl restoration, begun in 1933, has now under way projects on almost half of the 7,500,000 acres determined as necessary to safeguard an adequate seed stock. Even with actual restoration incomplete on many areas the protection afforded birds during nesting, wintering, and migratory periods has materially contributed to the estimated increase of this valuable resource from a low of 25,000,000 birds in 1935, to 70,000,000 birds in 1940. However, the present population is hardly more than half of what it was in 1900.

The timing of projects for the preservation of replaceable wildlife resources must be on a long-time basis and in accordance with a continental plan, to avoid the entire loss of seed stock. Within the over-all program there are many short-time projects necessary for increased efficiency of operation or for speeding up restoration. These projects, such as smaller water impoundments, will in the aggregate exert a pronounced effect on the program as a whole.

Cooperation Among Agencies

The points brought out above should serve to assist in the evaluation of projects submitted, not only by wildlife agencies, but by other agencies in whose work wildlife management plays a secondary role. A review of the wildlife habitat requirements on public-works projects involving water impoundments will frequently permit modification of the original plans to provide for controlled water levels, adequate water supplies, and food and cover planting. Consideration of these features may, at very little increased cost, greatly add to the value of the projects themselves and materially increase their value for wildlife.

Project proposals of the types described in this statement should always be examined in the light of possible modifications to add wildlife benefits to those already expected.

The close cooperation of various Federal, State, and private agencies in the wildlife conservation program will result in important benefits to wildlife generally.

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